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TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

FIFTY-FIRST ANNUAL REPORT

1938



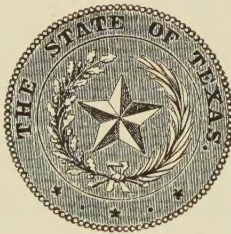
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

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AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

STATION STAFF†

MAIN STATION

Administration:

A. B. Conner, M. S., Director
 R. E. Karper, M. S., Vice-Director
 P. C. Mangelsdorf, Sc. D., Assistant Director
 Clarice M. Turner, B. A., Secretary
 M. P. Holleman, Chief Clerk
 Reed McDonald, Assistant Chief Clerk
 Chester Higgs, Executive Assistant
 Howard Berry, B. S., Technical Assistant

Chemistry:

G. S. Fraps, Ph. D., Chief; State Chemist
 J. F. Fudge, Ph. D., Chemist
 A. R. Kemmerer, Ph. D., Chemist
 T. L. Ogier, B. S., Associate State Chemist
 E. C. Carlyle, M. S., Associate Chemist
 P. F. Macy, Ph. D., Associate Chemist
 S. H. Wender, Ph. D., Associate Chemist
 S. E. Asbury, M. S., Assistant State Chemist
 A. J. Sterges, M. S., Assistant Chemist
 *Ray Treichler, M. S., Assistant Chemist
 W. W. Meinke, B. S., Assistant Chemist
 G. L. Smith, B. S., Assistant Chemist
 S. M. Greenburg, B. S., Assistant Chemist
 J. L. Kelch, B. S., Assistant Chemist
 F. C. Pack, B. S., Assistant Chemist
 W. H. Walker, Analyst
 Velma Graham, Analyst

Horticulture:

S. H. Yarnell, Sc. D., Chief
 W. S. Flory, Ph. D., Horticulturist

Range Animal Husbandry:

J. M. Jones, A. M., Chief
 B. L. Warwick, Ph. D., Animal Husbandman
 J. H. Jones, B. S., Animal Husbandman
 S. P. Davis, Wool and Mohair Investigations
 R. O. Berry, Ph. D., Assoc. Geneticist

Entomology:

F. L. Thomas, Ph. D., Chief; State Entomologist
 H. J. Reinhard, B. S., Entomologist
 R. K. Fletcher, Ph. D., Entomologist
 W. L. Owen, Jr., M. S., Entomologist
 J. C. Gaines, Jr., Ph. D., Entomologist
 S. E. Jones, M. S., Entomologist (P. O., Winter Haven)
 *J. N. Roney, M. S., Entomologist
 Henry Menusan, Jr., Ph. D., Entomologist
 G. A. Russell, Pharm. G., B. S., Agent (coop. U.S.D.A.)
 Cecil E. Heard, B. S., Chief Foulbrood Inspector
 W. C. O'Neal, B. S., Foulbrood Inspector

Agronomy:

E. B. Reynolds, Ph. D., Chief
 R. E. Karper, M. S., Agronomist
 P. C. Mangelsdorf, Sc. D., Agronomist
 R. L. Hensel, M. S., Agronomist
 H. V. Geib, Ph. D., Field Representative, Soil Cons. Research (coop. U.S.D.A.)
 E. S. McFadden, B. S., Associate Agronomist (coop. U.S.D.A.)
 D. T. Killough, M. S., Agronomist
 T. R. Richmond, Assistant Agronomist (coop. U.S.D.A.)

H. E. Rea, B. S., Agronomist
 D. A. Reid, M. S., Agronomist (Amarillo)
 R. E. Harper, B. S., Asst. Agronomist (coop. U.S.D.A.)

Publications:

A. D. Jackson, Chief

Veterinary Science:

H. Schmidt, D. V. M., Chief
 H. A. Smith, M. S., D. V. M., Veterinarian
 P. L. Piercy, D. V. M., Veterinarian
 R. D. Turk, D. V. M., Veterinarian

Plant Pathology and Physiology:

A. A. Dunlap, Ph. D., Chief
 W. N. Ezekiel, Ph. D., Plant Pathologist
 *G. M. Watkins, Ph. D., Plant Pathologist
 L. M. Blank, Ph. D., Assoc. Plant Pathologist (coop. U.S.D.A.)
 G. A. Greathouse, Ph. D., Assoc. Plant Physiologist (coop. U.S.D.A.)
 N. E. Rigler, Ph. D., Plant Pathologist
 G. E. Altstatt, M. S., Plant Pathologist

Farm and Ranch Economics:

L. P. Gabbard, M. S., Chief
 C. A. Bonnen, M. S., Farm Management Specialist
 C. H. Hamilton, Ph. D., Economist, Rural Life
 W. E. Paulson, Ph. D., Marketing Specialist
 A. C. Magee, M. S., Economist in Farm Management
 H. C. Bradshaw, M. A., Economist, Farm Taxation
 P. H. Czarowitz, B. A., Field Asst in Farm and Ranch Records

Rural Home Research:

Jessie Whiteacre, Ph. D., Chief
 Mary Anna Grimes, M. S., Textile and Clothing Specialist
 Sylvia Cover, Ph. D., Foods Specialist

Soil Survey:

W. T. Carter, B. S., Chief (coop. U. S. D. A.)
 E. H. Templin, B. S., Soil Surveyor (coop. U.S.D.A.)
 J. W. Huckabee, Jr., B. S., Soil Surveyor
 I. C. Mowery, B. S., Soil Surveyor
 H. M. Smith, B. S., Asst. Soil Surveyor (coop. U.S.D.A.)

Botany:

V. L. Cory, M. S., Acting Chief (P. O. Sonora)

Swine Husbandry:

Fred Hale, M. S., Chief
 C. W. McMath, M. S., Swine nutritionist

Dairy Husbandry:

O. C. Copeland, M. S., Acting Chief
 F. E. Hanson, M. S., Associate in Dairy Mfg.

Poultry Husbandry:

R. M. Sherwood, M. S., Chief
 J. R. Couch, M. S., Poultry Husbandman
 L. E. James, B. S., Asst. Poultry Husbandman

Agricultural Engineering:

H. P. Smith, M. S., Chief

*On leave 1938-39

†As of May 1939.

Wildlife Research:

W. P. Taylor, Ph. D., Chief (coop. U. S. D. A.)
Valgene Lehman, B. S., Field Biologist (coop. U. S. D. A.)

Main Station Farm:

J. E. Roberts, B. S., Superintendent

Apiculture, San Antonio:

H. B. Parks, B. S., Chief
A. H. Alex, B. S., Queen Breeder

Members of Teaching Staff Carrying Cooperative Projects on the Station

G. W. Adriance, Ph. D., Horticulture
S. W. Bilsing, Ph. D., Entomology
D. Scoates, A. E., Agricultural Engineering
A. K. Mackey, M. S., Animal Husbandry
R. G. Reeves, Ph. D., Biology
J. N. Quisenberry, Ph. D., Genetics

Feed Control Service:

F. D. Fuller, M. S., Chief
James Sullivan, Assistant Chief
S. D. Pearce, Secretary
J. H. Rogers, Feed Inspector
K. L. Kirkland, B. S., Feed Inspector
S. D. Reynolds, Jr., Feed Inspector
P. A. Moore, Feed Inspector
E. J. Wilson, B. S., Feed Inspector
H. G. Wickes, D. V. M., Feed Inspector
J. K. Francklow, Feed Inspector
R. A. Turck, Feed Inspector

J. S. Mogford, M. S., Agronomy
F. R. Brison, M. S., Horticulture
C. N. Shepardson, M. S., Dairy Husbandry
A. L. Darnell, M. A., Dairy Husbandry
V. A. Little, M. S., Entomology
P. B. Pearson, Ph. D., Animal Husbandry

SUBSTATIONS**No. 1, Beeville, Bee County:**

R. A. Hall, B. S., Superintendent
E. M. Neal, B. S., Animal Husbandman

No. 2, Tyler, Smith County:

P. R. Johnson, M. S., Superintendent (coop. U. S. D. A.)
J. C. Ratsek, Ph. D., Horticulturist, Rose Investigations
E. W. Lyle, Ph. D., Plant Pathologist, Rose Disease Investigations
J. B. Pope, M. S., Project Leader, S. C. S. (coop. U. S. D. A.)
O. C. Word, B. C. E., Agrl. Engineer, S. C. S. (coop. U. S. D. A.)

No. 3, Angleton, Brazoria County:

R. H. Stansel, M. S., Superintendent
H. M. Reed, B. S., Horticulturist

No. 4, Beaumont, Jefferson County:

R. H. Wyche, Superintendent
A. L. Martin, Ph. D., Plant Physiologist
H. M. Beachell, M. S., Asst. Agronomist (coop. U. S. D. A.)

No. 5, Temple, Bell County:

C. H. McDowell, M. S., Superintendent (coop. U. S. D. A.)
C. H. Rogers, Ph. D., Plant Pathologist
H. O. Hill, B. S., Project Leader, S. C. S. (coop. U. S. D. A.)

No. 6, Denton, Denton County:

P. B. Dunkle, M. S., Superintendent
I. M. Atkins, B. S., Asst. Agronomist (coop. U. S. D. A.)

No. 7, Spur, Dickens County:

R. E. Dickson, B. S., Superintendent (coop. U. S. D. A.)
B. C. Langley, M. S., Agronomist, (coop. U. S. D. A.)
C. E. Fisher, M. S., Asst. Soil Conservationist (coop. U. S. D. A.)

No. 8, Lubbock, Lubbock County:

D. L. Jones, Superintendent
Frank Gaines, Irrig. and Forest Nurseryman

No. 9, Balmorhea, Reeves County:

J. J. Bayles, B. S., Superintendent

No. 10, College Station, Brazos County:

R. M. Sherwood, M. S., In charge
L. J. McCall, Farm Superintendent

No. 11, Nacogdoches, Nacogdoches County:

H. F. Morris, M. S., Superintendent

No. 12, Chillicothe, Hardeman County:

J. Roy Quinby, M. S., Superintendent (coop. U. S. D. A.)
J. C. Stephens, M. S., Assoc. Agronomist (coop. U. S. D. A.)

No. 14, Sonora, Sutton-Edwards Counties:

W. H. Dameron, B. S., Superintendent
I. B. Boughton, D. V. M., Veterinarian
W. T. Hardy, D. V. M., Veterinarian
V. L. Cory, M. S., Range Botanist
O. G. Babcock, B. S., Asst. Entomologist (coop. U. S. D. A.)
O. L. Carpenter, Shepherd

No. 15, Weslaco, Hidalgo County:

W. H. Friend, B. S., Superintendent
J. F. Wood, B. S., Horticulturist
G. H. Godfrey, Ph. D., Plant Pathologist
T. B. Randolph, B. S., Entomologist
J. L. Heid, B. S., Chemist (coop. U. S. D. A.)

No. 16, Iowa Park, Wichita County:

L. E. Brooks, B. S., Superintendent
B. S. Pickett, M. S., Horticulturist

No. 19, Winter Haven, Dimmit County:

E. Mortensen, B. S., Superintendent
L. R. Hawthorn, B. S., Horticulturist (coop. U. S. D. A.)
S. S. Ivanoff, Ph. D., Plant Pathologist

FIELD LABORATORIES**Apicultural Research Laboratory, San Antonio:**

H. B. Parks, B. S., Apiculturist, in charge (also Chief, Division of Apiculture)
A. H. Alex, B. S., Queen Breeder

East Texas Pasture Investigations Laboratory, Rt. 1, Lufkin:

E. K. Crouch, B. S., Agronomist in charge
Truck Crop Insect Investigations Laboratory, Dickinson:

M. J. Janes, Ph. D., Entomologist in charge

Loco Weed Research Laboratory, Alpine:

Frank P. Matthews, Ph. D., Veterinarian in charge (coop. U. S. D. A.)

Tomato Disease Laboratory, Jacksonville:

P. A. Young, Ph. D., Plant Pathologist in charge

Tomato Disease Laboratory, Yoakum:

A. L. Harrison, Ph. D., Plant Pathologist in charge

Sweet Potato Investigations Laboratory, Gilmer:

R. E. Wright, M. S., Horticulturist in charge

Grape Investigations Laboratory, Montague:

U. A. Randolph, B. S., Horticulturist in charge

Cotton Insect Laboratory, Presidio:

A. J. Chapman, B. S., Assoc. Entomologist in charge (coop. U. S. D. A.)



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Fifty-first Annual Report, 1938

A. B. CONNER, Director

The Texas Agricultural Experiment Station is the agricultural research division of the Agricultural and Mechanical College of Texas. Its work at the Main College at College Station in laboratories and on field areas is supplemented by work at sixteen substations and nine field laboratories serving the different agricultural regions of the State.

The work of the Agricultural Experiment Station is concerned with the development of the State's agricultural resources and opportunities. This development is possible only by increasing our knowledge of the resources about us and of means of developing and preserving these resources so that they will yield up the greatest returns and opportunities to the citizenship.

There are many specific examples of work of the Agricultural Experiment Station that has had a profound influence upon our well-being. The development of the grain sorghums in Texas has enabled us to produce half the nation's output of this crop. It has afforded a suitable grain crop for West Texas and is even grown to a considerable extent in East Texas. The Agricultural Experiment Station has shown that cotton is a crop able to resist drouth comparable with the grain sorghums and a great cotton producing area in West Texas has been developed, which, together with other agricultural crops and livestock, has brought great wealth to that region. The Texas Station has developed a vaccine for the control of soremouth in sheep and goats which is now widely used throughout the sheep and goat producing area. This development also lends protection to lamb feeders in other states in feeding and finishing Texas lambs. The Texas Station has pioneered in the development of practical methods for conserving soil and water and its work has aided greatly in developing and putting into effect the present far flung soil and water conservation program. The Texas Station has developed two new sweet corns, Honey June and Surcropper Sugar, suitable for Texas conditions and this development has not only provided a better product for early shipment to northern consuming centers than the common field corn but has also resulted in the establishment of canning plants for processing this product within the State. The Texas Station has developed strains of wheat and oats resistant to stem and leaf rust and this development has made possible better acre production in areas where stem and leaf rust are prevalent. In fact this development promises to extend greatly the area on which these crops can be grown for grazing and for grain production in South Texas. The Texas Station has developed a strain of milo resistant to so-called milo disease and this strain is now rapidly replacing the old crop susceptible to this disease. The Texas Station has developed five new yellow corns carrying relatively higher vitamin A content than the common white varieties and these are rapidly coming into general use in the corn producing area of the State. Many

other contributions of direct value to the farmer and ranchman could be mentioned. It should also be said that these contributions have an indirect benefit to all the people.

The work of the Agricultural Experiment Station also furnishes to the several institutions engaged in teaching agriculture reliable information to impart to students. It serves in a definite way the Extension Service in the application of reliable facts and information. It likewise furnishes to vocational teachers reliable information for teaching. The results of research are published and distributed to farmers, ranchmen, and to others interested, and to libraries and agencies engaged in the dissemination of agricultural information.

The following report shows the scope of work of this agency and the progress made during the year in solving or alleviating some of the more urgent agricultural problems.

ORGANIZATION AND WORK

The Agricultural Experiment Station System comprises the Main Station with twenty divisions at College Station, sixteen substations in the several agricultural regions of the State, and nine field laboratories, as follows:

Divisions

Administrative	Botany
Veterinary Science	Swine Husbandry
Chemistry	Dairy Husbandry
Horticulture	Poultry Husbandry
Range Animal Husbandry	Rural Home Research
Entomology	Apiculture
Agronomy	Feed Control Service
Plant Pathology and Physiology	Agricultural Engineering
Farm and Ranch Economics	Wildlife Research
Soil Survey	Publications

Substations

No. 1, Beeville, Bee County	No. 11, Nacogdoches, Nacogdoches County
No. 2, Tyler, Smith County	No. 12, Chillicothe, Hardeman County
No. 3, Angleton, Brazoria County	No. 14, Sonora, Sutton-Edwards Counties
No. 4, Beaumont, Jefferson County	No. 15, Weslaco, Hidalgo County
No. 5, Temple, Bell County	No. 16, Iowa Park, Wichita County
No. 6, Denton, Denton County	No. 19, Winter Haven, Dimmit County
No. 7, Spur, Dickens County	
No. 8, Lubbock, Lubbock County	
No. 9, Balmorhea, Reeves County	
No. 10, College Station, Brazos County	

Field Laboratories

Apiculture Research Laboratory, San Antonio, Bexar County.
 Truck Crop Insect Investigations Laboratory, Dickinson, Galveston County.
 Cotton Insect Laboratory, Presidio County.

Loco Weed Laboratory, Alpine, Brewster County.
 East Texas Pasture Investigations Laboratory, Lufkin, Angelina County.
 Tomato Disease Laboratory, Jacksonville, Cherokee County.
 Tomato Disease Laboratory, Yoakum, Lavaca County.
 Sweet Potato Laboratory, Gilmer, Upshur County.
 Grape Laboratory, Montague, Montague County.

Lands

The following table shows the acreage available to the Agricultural Experiment Station of the Agricultural and Mechanical College of Texas, for research purposes:

	Total	State-owned	Leased or use donated
Main Station:			
Agronomy farm.....	94	94	.....
Horticultural farm.....	65	50	15
Veterinary Science.....	141	141	.....
Plant Pathology.....	4	2	2
Entomology.....	6	1	5
Substations:			
1. Beeville.....	449.1	449.7	.....
2. Tyler.....	455.2	455.2	.....
3. Angleton.....	159.3	159.3	.....
4. Beaumont.....	100	100	.....
5. Temple.....	647	94	553*
6. Denton.....	209.92	209.92	.....
7. Spur.....	413.92	413.92	.....
8. Lubbock.....	160	160	.....
9. Balmorhea.....	200	200	.....
10. College Station.....	920.8	920.8	.....
11. Nacogdoches.....	81.6	81.6	.....
12. Chillicothe.....	252	222	30
14. Sonora.....	3,461.63	3,461.63	.....
15. Weslaco.....	100	100	.....
16. Iowa Park.....	161.79	161.79	.....
19. Winter Haven.....	192	192	.....
Big Spring (Federal).....	80	.....	80
Field Laboratories:			
Apicultural (San Antonio).....	10	10	.....
East Texas Pasture (Lufkin).....	228.67	217.57	11.1
Truck Crop Insect (Dickinson).....	20	.....	20
Sweet Potato (Gilmer).....	65	.....	65
Grape (Montague).....	25	.....	25
Loco Weed (Alpine).....	1	.....	1
Cotton Insect (Presidio).....	6	.....	6
Tomato Disease (Jacksonville).....	45	.....	45
Tomato Disease (Yoakum).....	25	.....	25
Total.....	8,780.53	7,897.43	883.1

*Includes 447 acres owned by the Soil Conservation Service, U. S. D. A.

VETERINARY SCIENCE

Anaplasmosis in Cattle

A number of transmission experiments with different species of biting flies were attempted in the field during the last fly season. No transmissions were obtained in these experiments.

In tick transmission studies of this disease *Amblyomma maculatum*, *Dermacentor variabilis* and *Ixodes ricinus* were used. No transmissions were obtained.

Studies made on a diagnostic test using the so-called distilled water, mercuric chloride and formol-gel test indicate that these three tests cannot be relied upon to definitely pick out carrier animals in all cases. This leaves the inoculation of susceptible animals as the only available method of detecting carriers of the disease. No curative treatments were attempted during the year. These studies are being continued.

P. L. Piercy.

Pathological Conditions Accompanying Vitamin Deficiencies

This is a study of the symptomatology, pathology, and vitamin A requirements for cattle, sheep, and goats in which both young and old animals are being used. The longest survival period obtained in five aged ewes on a vitamin A free ration was 779 days. Of six aged goats on the same ration the longest period required for depletion was 782 days. Spectro vitamin A determinations were made by the Division of Chemistry on the livers of those animals that succumbed to vitamin A deficiency. The possible correlation between the appearance of urinary calculi and vitamin A deficiency is also being considered. A number of young and old animals are being continued on experiment with the object of collecting more data.

Four of five steers from the 1936-1937 experiment at Spur, which were brought to College Station, have died while on a level of 450 micrograms of carotene. The fifth steer is still living and has been on 450 micrograms for 650 days. At the present time he appears in perfect health and weighs 1200 pounds.

H. Schmidt.

The Role of Nicotinic Acid in the Nutrition of Ruminants

(In cooperation with School of Agriculture, A. & M. College of Texas)

Since the splitting off of nicotinic acid from the vitamin B complex and its recognition as the cause of pellagra in the human and black tongue in dogs and a similar disease complex in pigs, it has become possible to determine its precise effect upon ruminants. A study with this in view has been undertaken using lambs for the experimental animal. A pre-

liminary experiment has been completed but definite conclusions cannot be drawn from it. The investigation is being continued.

P. B. Pearson, H. Schmidt, A. K. Mackey.

Infectious Bovine Abortion

(In cooperation with School of Agriculture, A. & M. College of Texas)

The dairy herd of the Feeding and Breeding Station remains under observation. During the year one abortion occurred among 50 pregnancies. In this case the agglutination test for Bang's disease was negative. The breeding efficiency of the herd continues to be good. The 50 pregnancies required 72 services or an average of 1.44. Three cows accounted for 17 of these services. When these three cows are eliminated it required 1.17 service per conception.

The College dairy herd now consists of two units, the main herd and the farm herd. In the main herd there were 115 conceptions requiring 163 services. One abortion occurred but the cow remained negative to the Bang test. In the farm herd there were 26 pregnancies requiring 35 services. The farm herd had no abortions although it consists of those animals eliminated from the main herd that became either positive or suspicious to the Bang test after the herd had originally been freed of Bang's disease. It was established as a precautionary measure with the view of keeping the main herd negative to the Bang test.

H. Schmidt, R. D. Turk, O. C. Copeland and C. N. Shepardson.

Trichomonad Abortion in Cattle

(In cooperation with School of Agriculture, A. & M. College of Texas)

The College dairy herd is continued under observation for the possibility of a new out-cropping of trichomonad abortion. A number of suspicious animals were examined during the year but no new infection was discovered. Three of the bulls originally suffering with this disease but which had undergone prolonged treatment are still being used in the herd.

H. Schmidt, R. D. Turk, C. N. Shepardson.

Poisonous Plants in the Davis Mountains Area

(In cooperation with Bureau of Animal Industry, U. S. D. A.)

Red-Stemmed Peavine (*Astragalus emoryanus*) Poisoning. Late frosts destroyed most of the young plant crop that had come up on the range so that range outbreaks of this poisoning did not occur. A study of the toxicity and clinical behavior of the poisoned animals was conducted. Evidence collected so far indicates that more than one poisonous principle may be involved in producing fatal results in poisoned animals. Evidence collected also points to a difference in toxicity of the plant, depending upon the kind of soil on which it grows. These observations are being continued.

Sacahuista Poisoning. Experiments with both rats and sheep showed that the presence of green feed is necessary to complete or produce the photosensitization and poisonous effect of sacahuista.

Sartwellia flaveriae. Alcoholic extracts of this plant were found to be toxic for rats. In some cases there was considerable liver necrosis as was the case when the plant was fed to goats, but in other rats there was practically no necrosis of the liver. Feeding the extract to rats for a considerable period of time failed to produce a progressive cirrhosis of the liver.

Drymaria pachyphylla. Severe losses from this plant occurred in Hudspeth and Culberson counties during the summer of 1938. The plant was found to cover a much greater area than was heretofore known. Alcoholic and water extracts of the plant were not toxic for either sheep or rats, and the plant material was still toxic for sheep after the extractions were made.

Photosensitization from Sudan Grass. Two outbreaks of photosensitization in sheep were observed on the same patch of grass. In one case it was second growth grass and in the other case third growth grass. All cases recovered after the grass was eaten off. There was no icterus in these cases.

Frank P. Mathews.

Loco Weed Poisoning

(In cooperation with Bureau of Animal Industry, U. S. D. A.)

No additional field experiments were conducted during the year because suitable areas where loco was prevalent enough for such work were not available. During 1936 and 1937 the greater part of the loco in the Davis Mountains area for some unknown reason died before reaching the fruiting stage and it is believed that this accounts for the scarcity of the weed during 1938.

Frank P. Mathews.

Jimmies in Sheep and Goats

(In cooperation with Bureau of Animal Industry, U. S. D. A.)

Pasture experiments again indicate that feeding of bone meal and salt mixtures is beneficial in the prevention of this disease. The exact cause of the disease has not yet been determined. The feeding of grass collected from the area involved and given water obtained from dirt tanks, in the same region produced the trouble in two out of four sheep on experiment. The sheep used in this experiment were native to the area involved. In another experiment with 25 sheep obtained from an area where the disease is not prevalent and with which the experiment was repeated gave negative results. These studies are being continued.

Frank P. Mathews.

Loin Disease in Cattle

Bacteriological studies of loin disease are being continued. No additional source of possible toxic material on the range responsible for loin disease has been uncovered during the year.

H. Schmidt.

Effect of Moldy Feed on Sheep and Other Farm Animals

Work on this project has been interrupted on account of lack of culture material from the field. For a number of years there have been no complaints from poisoning in sheep by spoiled feed. Until such new cases occur work on this project must remain inactive.

H. Schmidt.

Serum Calcium and Inorganic Phosphorus of Sheep

This project is being carried on at Texas Substation No. 14, Sonora, and is reported upon at that point.

H. Schmidt.

Swamp Fever in Horses and Mules

Work on this project has been suspended on account of lack of material but will be resumed when conditions and facilities permit.

H. Schmidt.

CHEMISTRY

Factors of Soil Fertility

Work on the effect of various factors, such as calcium carbonate and acidity, on the phosphoric acid, potash and nitrogen taken from soils by crops, is being continued, and some of it is being prepared for publication. Studies of the fixation of phosphates and the availability of soil phosphates and soil potash to plants have been continued. The quinhydrone electrode has been found to give decidedly higher pH on some slightly acid Texas soils than the glass electrode.

G. S. Fraps and P. F. Macy.

Soils

The study of the chemical composition of typical Texas soils is being continued. The results of chemical analyses of soils of Cass, Dickens, Falls, Hardeman, Polk, Scurry, and Wheeler Counties are being prepared for publication. The constituents of these soils are being graded in five grades, according to the quantity present with Grade 1 being the highest and Grade 5 the lowest.

G. S. Fraps and J. F. Fudge.

Nitrification

Nitrification in some soils of low nitrifying capacity has been increased by additions of phosphates. These results will soon be published in Soil Science. Nitrites are decomposed by acid soils, but apparently nitrites are not formed from ammonia undergoing nitrification in sufficient quantity to cause a loss of nitrogen. This work is being prepared for publication.

The nitrogen of calcium cyanamid does not nitrify readily in soils of high nitrifying capacity, and even after inoculating with cultures of nitrifying organisms after several months of incubation. Apparently stable substances are formed which destroy the nitrifying organisms or hinder their action. This study is being continued.

Work is being continued on the seasonal variations in the numbers of the nitrifying and other organisms in field soils, variations of the numbers at different depths, the numbers of the nitrifying organisms required to oxidize a definite amount of ammonia nitrogen and the estimation of the nitrifying capacity of Texas soils and the nitrification of soil organic compounds.

Silica gel offers a good medium for the growth of the nitrifying and some other organisms, but further work is needed to develop methods for preparation of gels which are acid.

G. S. Fraps and A. J. Sterges.

Cotton Root Rot

Organic substances occur in the roots of certain plants resistant to the growth of the cotton root rot fungus which are toxic to the root rot fungus, which do not contain nitrogen, and which are not alkaloids. The work completed to date, by Ezekiel and Fudge, has been published in the Journal of Agricultural Research and a similar paper presented at a meeting of the Texas Academy of Science.

J. F. Fudge.

Small amounts of zinc, manganese, boron, copper and iron added to a liquid medium were favorable to the growth of the root rot fungus and increased the yield. In larger quantities, these elements were injurious, copper being most toxic, then manganese followed by zinc, while boron, ferric iron, ferrous iron, or aluminum were less toxic. The use of calcium nitrate instead of ammonium nitrate as the source of nitrogen or the addition of two per cent agar completely counteracted the toxicity of manganese and zinc except at very high concentrations. The toxicity of zinc was markedly increased by acidifying. The addition of calcium carbonate completely counteracted the toxicities of manganese and zinc when used at rates which were otherwise toxic, probably because the manganese and zinc were made less soluble. Fifth-normal nitric acid did

not extract toxic substances from several soils which are unfavorable to root rot, when evaporated to dryness and made up as a neutral nutrient solution. The juice expressed from cotton roots grown on an acidified soil (on which root rot does not flourish) increased the yield of root rot fungus when used in complete mineral nutrient solution, showing that such juice did not contain toxic substances. There was thus no evidence that the elements mentioned occur in toxic amounts in soils or plants.

Calcium cyanamid, although toxic to nitrifying organisms and some other forms of life, was not toxic to the root rot fungus at as high as 1250 p.p.m. in Houston black clay and Wilson clay loam soils. In nutrient solution it was highly toxic to the root rot fungus at 500 p.p.m. and non-toxic at 100 p.p.m. with calcium nitrate as the source of nitrogen, while with ammonium nitrate as the source of the nitrogen it was less toxic, since it reduced the yield only one-half at the maximum rate of 2500 p.p.m.

Cotton seedlings in sterilized agar-dextrose-mineral cultures were killed by the root rot fungus within two weeks after inoculation, while non-inoculated plants and plants in cultures contaminated with three different actively-growing molds were in good condition. Profuse mycelial growth and sclerotia formation occurred in moist soil added to well-developed agar cultures of the fungus in the bottom of beakers. Although roots of cotton planted in the soil grew through the original culture as well as through the new fungal growth, the tops had shown no indication of infection by the fungus by three months after planting.

Besides the work reported herewith, other work has been done in co-operation with the Division of Plant Pathology and Physiology.

P. F. Macy.

The Relation of Soil Composition to Plant and Animal Deficiencies

The study of the relation of the chemical composition of soil to plant and animal deficiencies has been continued. Particular attention was given to the phosphoric acid, protein, and lime content of the forage. During the year, 1086 forage samples have been collected, 191 samples were from two counties in the Gulf Coast Prairie, 360 from seven counties in the Rio Grande Plain, 210 from nine counties in the East Texas Timber Country, and 325 from ten counties in Northwest Texas. Crude fiber, water, ash, potash, manganese, and copper have been determined in a number of these samples. A large proportion of the samples contained less phosphoric acid than has been shown to be required for the proper development of cattle. Protein is also probably deficient in a number of these samples.

A short paper discussing the lime, phosphoric acid, and protein content in forage grasses in the East Texas Timber Country was published in Volume 2 of the Proceedings of the Soil Science Society of America.

A study was made of the relations between the protein, phosphoric acid, and lime contents of young Bermuda and young and mature little blue-

stem grasses and the nitrogen, active phosphoric acid, and active lime in the soils on which they grew. Both young and mature bluestem grasses were deficient in phosphoric acid and mature bluestem was deficient in protein. This work will appear in the proceedings of the Soil Science Society of America.

Results of the study of the composition of forage plants of the East Texas Timber Country, Gulf Coast Prairie, and Rio Grande Plain are being prepared for publication.

A study of the effects of fertilization upon the chemical composition of a Lake Charles clay at Angleton has been continued and the results will soon be prepared for publication. Similar work is being done with a Crowley clay loam at Substation No. 4 at Beaumont. This work is in cooperation with the Division of Agronomy.

J. F. Fudge.

Loco Poison

Various methods were tried for concentrating and isolating the poisonous principle of the loco weed. Apparently the instability of the poison renders its isolation in a pure form very difficult. The work is being continued.

G. S. Fraps.

Productive Values of Animal Feeds

The productive energy of a standard mixture of chicken feeds has been estimated by means of experiments with chickens, and the results have been submitted for publication as a bulletin. The work on the productive energy of feeds is being continued.

G. S. Fraps and E. C. Carlyle.

Productive Energy of Human Foods

The productive energy of various foods is being compared with that of corn mean fed in a basal ration, by means of experiments with chickens. The chickens are analyzed to ascertain their content of protein and fat, from which the gain in energy is calculated. Seven experiments of this kind were made during the year, the foods studied including patent flour, low-grade flour, clear flour, wheat gray shorts, casein, starch and hydrogenated oil. Some 88 digestion experiments were made with chicks, on the feeds mentioned above and also on cooked navy beans, cooked black eye peas, cooked lima beans and yeast. Digestion experiments numbering 46 were made with rats. Iron, copper, and manganese were determined in some of the foods. Calculations of previous work indicated that wheat bran not only did not contribute to the gain of energy of the growing chickens, but was detrimental, the gain being less than if the wheat bran was not fed at all, in spite of a good appetite for the mixture containing

wheat bran and good gains in growth. Some of this work is being prepared for publication.

G. S. Fraps and E. C. Carlyle.

Variations in the Vitamin Content of Texas Foods

The study of the relation between the carotene content of foods as measured by chemical methods and the vitamin A potency as measured by rats has been continued. The method of procedure has been changed, so that the comparison is made between the feed being tested and definite amount of carotene dissolved in wesson oil in each set of animals, which is practically the U.S.P. method. The results are expressed in International units of vitamin A, instead of the Sherman-Munsell units formerly used.

The study of the relation between the amount of vitamin A and carotene in butter as found chemically, and its vitamin A potency as measured by rats, has been published in Bulletin 560.

Work on the effect of different amounts of carotene on the health and longevity of rats has been continued. Effect of the quantity of carotene in the diet on the quantity of spectro vitamin A in the livers has been continued. Use of sulfanalamid failed to cure "sniffles" in the rats.

Estimations of the vitamin C content of a number of Texas foods have been made by Dr. W. W. Floyd of the Sam Houston State Teachers College at Huntsville, and the results were presented in a paper at the Dallas meeting of the American Chemical Society and will be published in Food Research.

G. S. Fraps, W. W. Meinke, and A. R. Kemmerer.

Quantitative Requirements of Vitamin A for Animals

The study of the quantitative requirements of chickens, beef cattle, pigs, and sheep for vitamin A has been continued in cooperation with the Divisions of Poultry Husbandry, Dairy Husbandry, Range Animal Husbandry, Swine Husbandry, and Veterinary Science. The work with beef cattle is also in cooperation with the Bureau of Animal Industry, United States Department of Agriculture. Carotene determinations were made at regular intervals on the alfalfa meal or other feeds used in this work. Livers, butter and body fats were analyzed for vitamin A and carotene. The effect of season upon the vitamin D content of eggs was continued in cooperation with the Division of Poultry Husbandry. Further information on these studies will be given by the various cooperating Divisions.

The quantity of carotene digested by rats and chickens was found to decrease as the quantity fed increased, and also to depend upon the carrier of the carotene. Some results are published in the Journal of Nutrition, Vol. 16, p. 309, but the work will be continued.

Contrary to previous results, vitamin A in fish oils mixed with feeds were found to be stable at refrigerator temperatures over a period of two months. The difference is ascribed to the fish oils recently used being of better quality than those used in the previous work.

The method for estimating carotene has been improved by the use of properly activated magnesium hydroxide to adsorb the impurities from the crude carotene. This method of selective adsorption is very easy and simple, but requires the use of an adsorbent which adsorbs xanthophyll but does not adsorb carotene. A description of the method was presented at the meeting of the Association of Official Agricultural Chemists, and will be published in their Journal. Serious difficulties in preparing suitable magnesium hydroxide have been encountered, and the method of preparation is being studied. The method of selective adsorption can be applied to the purification of carotene and other compounds.

A number of fish oils were assayed by the A. O. A. C. procedure for vitamin D potency. Only a few oils were found to be below the guarantee. Also the method of assay was studied, in an effort to determine what factors affect the assay. Light from ordinary Mazda lamps and the amount and ratio of calcium and phosphorus in the chick rations had considerable effect on calcification.

G. S. Fraps and A. R. Kemmerer.

Vitamins in Commercial Feeds

The work on this project is being prepared for publication.

G. S. Fraps and A. R. Kemmerer.

Iodine

The study of iodine in Texas foods, feeds, waters and soils has been continued, and publications presenting the results of the study are being prepared. Texas foods, feeds, and waters in nearly all cases contain sufficient quantities of iodine for humans and for various animals, so that there is no necessity for the addition of iodine to commercial feeds or to salt. The iodine content of some of the samples of foods and feeds was quite high, and in none of the samples was it low enough to indicate the need of additional iodine.

G. S. Fraps and J. F. Fudge.

Commercial Fertilizers

One thousand sixty-four samples of commercial fertilizers were collected and analyzed. In general, the composition was well up to that guaranteed by the manufacturers. The results of the inspection and analyses are published in Bulletin 565, and also definitions of terms and interpretations of results as adopted by the Association of Official Agricultural Chemists. Twenty-seven samples were analyzed to check upon

claims of non-acid forming quality. The Chief of the Division is State Chemist and is in charge of the fertilizer law. He is also the referee on fertilizers of the Association of Official Agricultural Chemists. The fertilizer manufacturers agreed upon 24 grades of mixed fertilizer to be sold in Texas during season 1938-39. Fertilizer statistics of Texas since 1926-27 are being compiled for publication.

G. S. Fraps, T. L. Olgier and S. E. Asbury.

Analyses of Commercial Feeds

The estimation of protein, fat, water, crude fiber, and ash, and the microscopic examination were made on about 3563 samples of feed for the Division of Feed Control. The hardness of 26 samples of cottonseed cake was tested. Calcium carbonate was determined in 190 samples, and salt in 303 samples. Lime and phosphorus were determined in a number of mineral feeds. Vitamin D carriers, chiefly fish oils, to the number of 24 were subjected to biological tests by means of chickens to see if they came up to guarantee. These results were published in Bulletin 566 by the Division of Feed Control. Assistance was also given in the formulation of definitions and rulings.

G. S. Fraps and T. L. Olgier.

Miscellaneous

Analyses were made of a number of irrigation waters, minerals, feeds, grasses, etc. Work is being done on the estimation of sodium in various samples of feeds. Investigation work is being done on various methods in use in the analytical work, to determine factors which influence results. Several samples of prickly pear were analyzed to determine amount of arsenic present.

The accuracy of the chemical glassware and apparatus used in the Division of Chemistry has been tested and only that which reaches a certain standard is accepted from dealers. A number of samples were analyzed for various Divisions of the Station.

G. S. Fraps and T. L. Olgier.

HORTICULTURE

Fruit Adaptability Tests

(In cooperation with Texas Extension Service)

Additional information on the cold requirements of peach varieties suggests that the 45 degree point (F.) is unsatisfactory for use in widely separated areas as a critical temperature. Budwood of Elberta brought into the greenhouse after 414 hours at or below 45° in the Winter Garden took less time to flower than wood of the same variety brought in after 885 hours in East Texas. However the number of hours at or below 60°

was in the neighborhood of 2000 at each location. Varieties do not behave the same on successive seasons with respect to the 45° temperatures at the same location. While some of this may be due to differences in greenhouse temperatures it appears that outside temperatures above 45° may have had something to do with the results.

One of the promising peach seedlings (T.S. 22678 from Miss McDougal of Bryan) has been found to require very little cold weather for normal spring activity. Another lot (T.S. 22682 from J. F. Rosborough, College Station) has yielded well at Substation No. 11, Nacogdoches the past season. Frank has done well both at this point and in the Winter Garden although some winters are too warm at the latter station. Henderson's Elberta cling is promising in East Texas. Hall's Yellow requires little if any dormancy at the Main Station and as a result blooms too early for the central and northern parts of the State. Some of the newer varieties recently received for trial at Substation No. 11 include Burbank's New July Elberta, Charlotte, Frankie, Yellow Hiley, Gold Standard and Winter-cheek.

Seedlings of superior individual trees of tung oil are being grown at Nacogdoches and at College Station in the hope of securing high yielding strains that are dependable. Factors under consideration include response to warm weather, time of bloom, yield, and proportion of oil.

At the Lower Valley station the papaya has been found to be both tender and variable. Certain strains secured from the U.S.D.A. Bureau of Plant Industry, Subtropical Fruit Research Laboratory, seem to be more satisfactory. It has been found practical at the same station to graft the hardy Mexican strains of avocado on to seedlings of certain West Indian varieties that grow well in Lower Valley soils. This work offers some possibility as the basis of a new industry for the area.

S. H. Yarnell, J. F. Rosborough, B. S. Pickett,
J. C. Ratsek, and substation superintendents.

Berry Adaptability and Breeding

At Substation No. 11, Nacogdoches, selections of the intervarietal crosses have been self pollinated and back-crossed to secure populations of these types. Certain varieties have been self pollinated and a few additional intervarietal crosses made. Work in improving the Nessberry is being continued at the Main Station. For further information on this work turn to the report of Substation No. 11.

H. F. Morris, S. H. Yarnell.

Citrus

Adaptability and Breeding: Tests are conducted at Substations No. 15 (Lower Rio Grande Valley) and No. 19 (Winter Garden). Perrine lemon, Mineola tangelo, and the thornless Mexican lime show promise at the

former station. There is a tendency toward the biennial cropping of satsumas in the Winter Garden. A list of crosses appears in the report of Substation No. 15. Citrange seedlings grown at College Station seem to be segregating for evergreen vs. deciduous foliage, and for shape and other leaf characters. All seedlings thus far have had modified trifoliate leaves.

W. H. Friend, E. Mortensen, J. F. Wood, S. H. Yarnell.

Rootstocks: At the Winter Garden Station rootstocks were found to affect the time of ripening of the cion varieties. Both trifoliate orange and citrange are satisfactory. No stock has been found to be superior to sour orange for the Lower Valley.

E. Mortensen, W. H. Friend.

Cultural Studies with Grapefruit: The work at the Lower Rio Grande Valley station includes studies of methods to overcome the bad effects of salt accumulations, the use of fertilizers and related materials, and the effect of applications of organic matter. A discussion of the effectiveness of various materials to cover pruning wounds is also included with the report of this station.

W. H. Friend, J. F. Wood.

Storage: Wax treatments have been useful in holding fruit in cold storage but are not as effective as moisture-retaining wrappers. Antiseptic washes have been useful with the Meyer lemon.

W. H. Friend.

Orchard Heating: No records were obtained during the past season because of lack of cold weather.

J. F. Wood.

Cytological Investigations: Examination of pollen mother cells of different species of Citrus shows a rather constant association of two, occasionally more chromosome pairs at first metaphase and earlier. This accounts for the erroneous report of eight instead of nine pairs made by Strasburger and by Osawa.

S. H. Yarnell.

Adaptability of Date Varieties

(In cooperation with Bureau of Plant Industry,
U. S. Department of Agriculture)

These plantings are at the Winter Garden and Lower Valley stations. Good crops are being secured at both locations. Transplanting of offshoots has been done successfully and palm growth is excellent. Only one variety, the Khadrawy, has ripened satisfactorily in the Lower Rio Grande Valley.

E. Mortensen, J. F. Wood.

Figs

Adaptability and Breeding: A large number of varieties previously untested have come into bearing at Substation No. 3, Angleton. No additional crosses were made during the past season because of the large number of seedlings on hand. These have been set in orchard form at Substation No. 3 and at the Main Station.

H. M. Reed, S. H. Yarnell, R. H. Stansel.

Processing Experiments: This work is being done at Substation No. 3, Angleton, and is reported in full with the other experiments at that station.

H. M. Reed.

Grapes

Adaptability and Breeding: As a result of studies on the adaptability of the vinifera varieties of grapes at the Winter Garden station a start has been made on commercial production in this area. The breeding program consists of selfing the self-fertile Munson varieties to secure new combinations of characters from the native and commercial parents. Seed has been obtained at Substation No. 19 and at the Main Station. Seedlings are being grown at the latter point. An extensive variety planting was made during the past season at the Grape Investigations Laboratory near Montague. Most of these are varieties of American origin.

E. Mortensen, U. A. Randolph, S. H. Yarnell.

Rootstocks: Dog Ridge has been found to be the best stock at Substation No. 19 since it is resistant to cotton root rot, to phylloxera and to root knot, it propagates readily and makes a good union with most varieties.

E. Mortensen.

Cultural Tests: Plantings have been made at the Grape Investigations Laboratory, Montague, for a series of tests to include the use of fertilizers, cover crops, spacing, pruning and the field control of insects and diseases. Carman is being used in all of these tests.

U. A. Randolph.

Processing Experiments: Juice obtained at the Grape Investigations Laboratory is bottled and shipped to Substation No. 3 for studies of blends, methods of processing, and by-products.

H. M. Reed, U. A. Randolph.

Peach Breeding

The two objects of this work are (1) to secure improved home and commercial varieties that produce well after a mild winter, and (2) to obtain early yellow freestone varieties of commercial quality that are dependable bearers in the northern portion of the State. Around 200 seedling trees of both types were placed in orchard form at College Sta-

tion this season. Other older trees should produce a few fruits this coming year.

S. H. Yarnell.

Plum Breeding

Crosses: Due to the early spring most varieties of plums both at the Wichita Valley station and at College Station were in full bloom by February 15. Because of the great hazard from frosts no breeding was done at either of these points. At Substation No. 19, fifteen intervarietal crosses gave poor sets due, in part at least, to unfavorable weather during and after the pollination period. Twenty-two seeds were secured from these crosses. A number of additions were made to the varietal collection of breeding material in the new orchard at College Station.

W. S. Flory, E. Mortensen.

Vegetative Key to Varieties: Measurements and notes have been taken on leaf and other vegetative characters of 34 varieties of plums grown in Texas. A preliminary vegetative key to these varieties has been arranged.

W. S. Flory.

Strawberry Adaptability and Breeding

At the Winter Garden station eight seedling selections outyielded all named varieties and four others yielded as well as Klondike, the best of the commercial varieties. Three of these have been named and distribution begun. These are Ranger (T68), Alamo (T21) and Rio Grande (T15). A fourth selection (T22), as yet unnamed, is an excellent home garden variety. These new varieties are described in the report of Substation No. 19. Results of a preserving test of these selections by H. M. Reed are included in the report of Substation No. 3.

E. Mortensen.

Truck Crop Adaptability Tests

Shipping Varieties: Accounts of the work along this line will be found with the reports of Substations No. 15, No. 16, and No. 19.

L. R. Hawthorn, W. H. Friend, J. F. Wood, B. S. Pickett.

Canning and Freezing Varieties: At the Lower Rio Grande Valley station the test is in cooperation with J. L. Heid of the U. S. D. A. Citrus Products Laboratory. The test includes English peas, lima and snap beans, and sweet corn. Results are presented in the report of Substation No. 15. At the Winter Garden station the work has been in cooperation with W. B. Cook of the Missouri Pacific railroad. Results with beets, carrots, spinach, English peas, and lima and snap beans are discussed in the report of Substation No. 19.

J. F. Wood, L. R. Hawthorn.

Vegetable Variety Descriptions: This is in cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture, and is being done at the Winter Garden station. Extensive notes were taken with Dr. Roy Magruder on the collections of eggplant and peppers during the past season.

L. R. Hawthorn.

Breeding Cabbage and Related Plants

Many of the crosses between botanical varieties have been selfed for F_2 or F_3 generations or, in some cases, back-crossed to the original parent lines. In the cross (broccoli x collards) x collards two selections were made of plants that showed promise of providing the type desired by the frozen broccoli packers. The terminal heads were small, the six to eight side shoots were about five inches in length when the compact heads were around an inch in diameter, and the stems about $\frac{3}{4}$ -inch in diameter. These were selfed and also crossed back to both pure broccoli and pure collard lines. Relatively large numbers of progeny seedlings have been set both at the Lower Valley substation and at College Station for further study. Second generation lines from broccoli selected for compact, small-budded, leaf-free heads and small plant size, and of collards selected for smaller plant size, sessile compact leaves, and dark green color show promising uniformity. No method tried, has yet proved very successful in carrying selected cabbage plants through to seeding; additional methods are being utilized with further selections.

W. S. Flory, J. F. Wood.

Factors Influencing the Quality and Yield of Onions

This work is being continued at the Winter Garden station and at outlying points, and is reported with the other vegetable experiments at Substation No. 19. Certain selections for freedom from splitting and seeding made at that station are very promising.

L. R. Hawthorn.

Pea Breeding

Increased interest in English peas, particularly by canners in South Texas, called attention to the lack of a well-adapted, high quality canning pea for that section. The Perfection, a standard "canner" in many regions, does not produce well in the South. Thomas Laxton yields well but it is chiefly a fresh pea and a "quick-freezer"; in large size of seed and other features it is less desirable as a canner. The pea breeding work has as its objective the production of a small to medium seeded, uniformly ripening, high yielding strain desirable for canning. Initial crosses at Substation No. 19 gave, from Early Perfectah x Thomas Laxton, 49 seeds; Wisconsin Early Sweet x Thomas Laxton, 17 seeds; Rogers Ace x Thomas Laxton, 12 seeds. At the Main Station lines containing Creole pea genes, provided by Dr. J. C. Miller of the Louisiana Station, served

as the basis for breeding work. The Creole pea has been grown for many years in the South. It is adapted here, and has many desirable characteristics. A number of seeds were obtained from crosses between Creole, and also certain of its derivatives, and Thomas Laxton.

W. S. Flory.

Irish Potatoes

Variety Test: Chippewa and Katahdin are giving better results as a fall crop in Cameron county than Bliss Triumph, the only variety now grown commercially.

Fertilizers: Little affect was obtained from the use of commercial fertilizers on potatoes near Los Fresnos.

W. H. Friend.

Sweet Potatoes

During the past year work has been undertaken at the Sweet Potato Investigations Laboratory near Gilmer on varietal and cultural work with this crop. In addition to variety trials a test of seedlings is being made in cooperation with the U. S. D. A. Bureau of Plant Industry. The cultural experiments include tests with commercial fertilizers, spacing, height of beds, time of harvest and size of seed.

R. E. Wright.

Tomatoes

Breeding: Improvement in adaptability includes better flavor and texture, bright red color, disease resistance, relative freedom from puffing, cracks and sunscald, and an extension of the harvest season. Since most varieties originated under conditions of climate much different than those of Texas, the most desirable hereditary factors for our conditions were not retained. Summerset, a Bonny Best-Cherry combination developed at the Winter Garden station, is heat resistant and sets well late in the season. Crosses have been made at the Lower Valley station and at the Main Station to secure new combinations of factors that will be more favorable for our conditions. At the latter point a cross between two old varieties, Alpha and Golden Queen, seems to have considerable promise. New crosses include Marglobe x San Marzano at Substation No. 15, Summerset x Bison at Substation No. 19, and Bison x a globe-fruited breeding selection at the Main Station.

L. R. Hawthorn, J. F. Wood, S. H. Yarnell.

Puff: The proportion of puffed fruit was very small at College Station during the past season. Even Marglobe, which frequently exceeds 40%, had only 8.2 and 13.3% for two strains. The following percentages are for fruits harvested in June: Alpha 2.3, Bison 1.4, Bonny Best 1.1, Earliana 0.0, Golden Queen 4.6, Summerset 0.0, and Walter Richard's Extra Early Globe 5.2. Most of the hybrids having small fruited tomatoes in their parentage had very small percentages or no puffed fruit.

S. H. Yarnell.

Cultural Treatments: Pruning to one or two stems resulted in higher early yields at the Winter Garden station, because of closer spacing. The fertilizer work at the Lower Valley station and near Los Fresnos is discussed in the report of Substation No. 15.

L. R. Hawthorn, W. H. Friend.

Mineral Content of Turnip Greens

A project to determine the variation in content of certain minerals in turnip tops grown under different conditions was started last season in cooperation with the divisions of Rural Home Research and Chemistry. Plantings were made at Substations No. 16 and No. 19, and at the Main Station. Harvests were made both from fertilized and unfertilized plats and turned over to the Division of Rural Home Research for drying.

B. S. Pickett, L. R. Hawthorn, S. H. Yarnell.

Ornamentals

Adaptability: Material for the adaptability tests at the different stations comes from a number of sources. Among these may be mentioned the Office of Foreign Plant Introduction of the U. S. Department of Agriculture, collections of native material mostly in the form of seeds, and seedlings grown to secure chance variation and in connection with the breeding work. In addition, a rather extensive test of varieties of bearded Iris has been made, many of which were obtained through the American Iris Society, and a collection of plants belonging to the Amaryllidaceae and Hemerocallideae is being made at College Station in cooperation with the American Amaryllis Society. This collection to date includes 116 accessions among which are represented 14 genera and 50-odd species. There are also five generic hybrids, several species hybrids and 28 horticultural varieties, many of which have resulted from interspecific hybridization.

Seedlings have been secured from a number of additional lots of seed collected by W. S. Flory in the Trans-Pecos and other sections of Texas. Several lots of young plants have been set in nursery row or field plantings for detailed observation. Eighteen recent accessions have been added to the collection of Zephyranthes.

A number of subtropical ornamentals common to Florida have been established at the Lower Valley station. An account of these is given in the report of Substation No. 15.

S. H. Yarnell, W. S. Flory, J. C. Ratsek,
and substation superintendents.

Breeding: Additional oleander crosses—working toward increased cold resistance—were made at Substation No. 19. Very few open-pollinated 1938 flowers set pods and no seed were secured from the cross pollinations. The few plants obtained from previous crosses have been multiplied by cuttings and the rooted cuttings set in the field.

When pollen from the Deciduous Holly, *Ilex decidua*, was used on the evergreen Yaupon, *I. vomitoria*, 32 berries, containing 126 seeds, resulted.

Number of pollinations, set 14 weeks after pollination, and acorns gathered, respectively, from the 1938 oak crosses follow: (1) Live x Burr—69, 16, 0; (2) Live x Overcup—170, 85, 31, and (3) Live x Post—157, 72, 34. Several seedling trees have already resulted from these crosses.

Five vigorous plants have resulted from the cross *Zephyranthes texana* x *Cooperia pedunculata*. Since diploid parthenogenesis has been reported to occur in the maternal parent, chromosome numbers, or flowering characters, or both, must be observed before determining if these plants are true hybrids.

W. S. Flory.

Further interspecific rose crosses were made at Substation No. 2 near Tyler during the past season. The seeds are being germinated and the seedlings grown at that point. Cuttings of representative seedlings are also being grown at College Station. Somatic chromosome counts are being made of these and of the parent plants.

J. C. Ratsek, S. H. Yarnell, W. S. Flory.

Propagation: Attempts to propagate the Ness hybrid oaks by means of stem cuttings were continued. Work involved softwood and hardwood cuttings, untreated, and treated at various time lengths and concentrations with plant growth substances. The work definitely indicates that neither indoleacetic nor indolebutyric acid solutions alone, give root stimulation of stem cuttings from mature trees. Vitamin B₁ (Betabion) treatment, following use of hormones, has given only negative results to date. The work is being continued by use of different growth substance solutions, especially of naphthalene acetic acid, on stem cuttings; by use of powder, instead of liquid bases for hormone application; by use of root cuttings instead of stem cuttings; and by use of cuttings from young instead of mature trees.

Several hundred seedlings of some 14 species of oaks are available for budding. Preliminary work indicates that a relatively large percentage of "takes" are to be expected from T-budding of these seedlings with hybrid oak buds.

Cytology: A technique, involving the use of colchicine, has been developed for rapid and efficient study of somatic chromosome complements of plants with many large chromosomes. The complements of several species of *Zephyranthes*, *Cooperia* and *Habranthus*, have been studied in detail by use of this method.

W. S. Flory.

Rose Investigations: A detailed account of this work on the effect of fertilizers, cultural and handling methods, understocks, and storage on the

amount of dieback may be found with the report of Substation No. 2, Tyler. A study of the effect of acidification of heavy soil has been made at Substation No. 6, Denton.

J. C. Ratsek.

Sweet Potato Investigations Laboratory

Gilmer

The Sweet Potato Investigations Laboratory is located in Upshur County, two miles south of Gilmer, on highway U. S. 271. The chief concern of the Laboratory is to increase the acre yield of sweet potatoes from the present average of 75 bushels per acre, to a level which will be profitable to the farmer. Operations were begun in February, 1938.

Fertilizer Test: Rates of application of 4-12-4, using 200 pound intervals and ranging from 0 to 1000 pounds per acre, were tested to determine the most profitable amount of fertilizer. The 400 pound application produced the highest total yield of 212 bushels, of which 121 bushels were U. S. No. 1's. In the analysis test, a deficiency of any of the essential elements (nitrogen, phosphorus, and potash) considerably reduced the yield, as well as the tonnage of vines. Response to increasing amounts of each of the elements was not consistent, due in all probability to the abnormally dry season.

Dates of Planting and Differential Spacings: Plantings were made on May 13, June 2, and June 30, using each of the following spacings: 9, 12, 15, 18, and 24 inches. Highest yields resulted from the May 13, planting. No significant differences in yields were recorded from the differential spacings. Total yields were slightly higher with the closer spacings, but the percentage of U. S. No. 1's was proportionately lower.

Height of Beds: Plants were set on the following beds: level, 3 inches, 6 inches, 9 inches, and 12 inches high. Although differences were not great, the 9-inch beds produced the highest yield of U. S. No. 1's, as well as total yield. Results of this test indicate that thorough preparation of the land is more important than height of beds.

Dates of Harvesting: Plants were set in the field on May 13, and plats were harvested after 116, 129, 143, 157, and 171 days. Total yields increased with each two-week interval throughout the harvest period. The maximum yield of U. S. No. 1's was harvested on October 17, after a growing period of 157 days. Distribution of rainfall during August and September materially affected this test.

Size of Seed: Porto Rican seed of the following sizes was bedded for this test: jumbo, U. S. No. 1, U. S. No. 2, turnip shape, and strings (less than $1\frac{3}{4}$ inches in diameter). The yield of No. 1's, as well as total yield, decreased as the size of seed roots was decreased. The highest percentage of U. S. No. 1's was produced from No. 1 seed. The length-diameter ratio

of U. S. No. 1's and U. S. No. 2's resulting from this test indicates that the shape of the sweet potatoes was not materially affected by the various size seed potatoes.

Variety Adaptability Studies: Although the Porto Rico is recognized as the leading commercial variety in the East Texas area, attention is being given eight leading varieties of other areas. The Triumph, primarily a starch variety but sometimes grown for early shipment to the North, produced the highest total yield of 248 bushels. The Louisiana Unit 1 produced 232 bushels, and the common Porto Rico 162 bushels. The Louisiana Unit 1, a selected strain of the Porto Rican variety, produced 150 bushels U. S. No. 1's per acre, as compared with 76 bushels for the regular Porto Rico.

The Laboratory is cooperating with the United States Department of Agriculture in studying the adaptability of older named and foreign varieties, as well as various seedlings, to the East Texas area. Eighty lots of this material were increased during 1938, and will be tested in replicated plats next season. Several lots of this material show considerable promise.

R. E. Wright.

Grape Investigations Laboratory

Montague

Grape Investigations Laboratory is located two and one-half miles southwest of Montague and nine miles northeast of Bowie, Montague County. Latitude is 33 degrees and 40 minutes north; longitude 97 degrees and 45 minutes west; and elevation approximately 1166 feet above sea level.

The Laboratory farm consists of 56 acres of land, of which about 7½ acres are now planted in grapes. Most of the land is typical of the fruit land in the northern portion of the West Cross Timbers.

The work at the Station was begun in January 1938. The purpose of the investigations is to study problems involved in the production of grapes, and to find ways of processing Texas grapes to find a ready market. Plantings have been made of a large number of the American grape varieties and a few of the Vinifera varieties. Studies will be conducted with the control measures of grapes insects and diseases. Tests will also be made with various root-stocks. Of the vines that started growth last spring 99.37 per cent made excellent growth the first season, indicating very satisfactory natural conditions for grape production.

Variety Test: Eighty-nine varieties of rooted plants were set out the first of March. The planting consisted of five plants of each variety for comparison with the Carman. Ninety-nine varieties have been grown from cuttings which will be planted in permanent locations in 1939. The plants and cuttings made good growth in spite of the long summer drought.

Of the approximately fifteen varieties being grown by growers in the northern area of the State, the Carman is the most popular one. It is highly resistant to insects and diseases, and seems to be better adapted to the soil and climatic conditions than other varieties. Virginia, Catawba, Delaware, Herbemont, America, Muench, Black Spanish, Wine King, Beacon, Fern Munson, Niagara, Concord, Minnie and Brilliant are also grown commercially. Grapes usually bloom late enough in the spring to escape the late freezes and frosts. The past spring was very exceptional in that the crop was almost completely destroyed. The vines were in full bloom when the freeze occurred on April 7, 8, and 9.

Cultural Test: A series of cultural tests with the Carman variety has been set up. It consists of twenty-seven treatments with five replications each. These treatments include pruning and training, fertilizing, cover crops, spacing, position of planting with reference to terraces, and elevation plantings. Winter cover crops were planted in the fall with wheat, oats, barley, Austrian winter peas, and vetch. Since these crops were planted very late, the rabbits have seriously damaged them. As the cultural treatments have just begun, no results have as yet been obtained. All vines are of the Carman variety.

Grape Insects and Diseases: The grape leafhopper is considered the most destructive insect and black rot the most serious disease. In local vineyards, leafhopper attacks were very numerous during the past season. Amount of black rot was especially light because of the exceptionally dry summer. A program of five spraying and dusting schedules has been outlined to combat the insects and diseases, but no applications were made during the past season. There have been no diseases or insect attacks on the station vineyard, aside from a slight damage from leaf-worms which occurred in June.

U. A. Randolph.

Grape Products Test: Grapes were secured from local growers during the past season. Juice was extracted and bottled from eleven varieties. The varieties tested in degrees Brix as follows: Delaware, 26.8; Virginia, 26.5; Black Spanish, 24.9; Herbemont, 24.7; Muench, 23.5; Catawba, 23.3; Carman, 22.95; Wine King, 21.9; Fern Munson, 21.4; American, 21.3; and Beacon, 19.7.

Analysis was made of ten commercial brands of grape juice. All of these samples had had sugar added. The Average Brix reading of these samples was 18.6; maximum 19.4; and minimum 17.2. With the juices extracted from grapes secured locally, all of the samples had a Brix reading higher than the maximum commercial sample, although the acid content of most of the local juices was higher. This indicates that it will probably not be necessary to add sugar to the local juices to keep the Brix/acid ratio near the commercial brands on the market.

Experiments are under way to produce a commercial grape juice from the varieties which are now being grown.

H. M. Reed, U. A. Randolph.

RANGE ANIMAL HUSBANDRY

Disease Resistance in Animals

(In cooperation with Division of Veterinary Science)

Selections of mice resistant to *Nippostrongylus muris* has been continued. The resistant selections have lower infestation than the susceptible selections, but have not yet reached the point where the animals are completely resistant. Irregularities in results of tests at different seasons of the year have been found to be definitely related to the temperature in which the host animals were kept. High summer temperatures which were depressing but not lethal to the host were also found to be highly deleterious to the parasite *in vivo*.

Selections of mice for resistance to loin disease toxin have been continued, but the extreme difficulty in holding the toxicity of the toxin at known levels has greatly hampered the progress. There is no doubt of a valid difference between our selected high and low lines, but there is still overlapping of the groups.

Preliminary work toward selection in sheep for resistance to the stomach worm *Haemonchus contortus* has been started. Monthly records are being made on both treated and untreated individuals under conditions of intense natural exposure and small preliminary selections have been made in both Rambouillets and Romneys. Deaths due to stomach worm infestation have occurred in the preliminary selected group of each breed. However, three Romneys and nine Rambouillets continue thrifty without treatment. Further exposure of these and their progeny may invalidate to some extent these findings. However, even though these animals may not be as resistant as they appear, they should represent a more favorable group for further breeding work than unselected animals. Pure cultures are being used in an attempt to work out a technique for testing very young lambs for resistance. Our tests show conclusively that new-born lambs are susceptible when the infective larvae are given them by stomach tube. However, little, if any, effect can be noted on the lamb until after the parasites have reached sexual maturity.

B. L. Warwick, H. Schmidt, R. D. Turk, R. O. Berry.

Cytological and Hybridization Studies with Sheep and Goats

The cytological study of preparations from amnions of sheep, goat and the goat x sheep hybrid embryos has been published during the year.

One of the wild species of true sheep, the Mouflon (*Ovis musimon*) is usually considered one of the progenitors of domestic sheep. Through the courtesy of Mrs. Belle J. Benchley, Executive Secretary of the San Diego Zoological Park, this Station was given a pair of adult Mouflons which we shipped to College Station for experimental breeding. No young

were born from the female Mouflon, nor were any matings seen, even though she was in the same pen with the Mouflon male continuously.

The Mouflon male was mated to both domestic sheep and to domestic goats. Six hybrid young were born from the cross with domestic sheep, but none from the cross with domestic goats. One of the goats had the external signs of pregnancy, but no young was born. Probably, resorption of the fetus took place as we had previously found when female goats were bred to domestic male sheep.

B. L. Warwick, R. O. Berry.

Inheritance of Polled Character in Fine-Wool Sheep

More Rambouillet rams of polled breeding have been tested but no additional rams have been identified as homozygous for the polled pair of genes. Further tests of white rams for the recessive black gene which was "contaminating" this stock as well as many other lines of breeding have pointed to the probability of there being *two* separate recessive pairs of genes, either of which gives black.

The Mouflon (*Ovis musimon*) was crossed with horned stock Rambouillet ewes and the F₁ hybrid males have horns while the hybrid females have knobs. This is the same as in both parental species, except for the shape of horn. We conclude that the principal pair of genes for horns is the same in the Mouflon and the horned stock Rambouillet (and Merino).

More sires are being tested to find polled rams which are free from the recessive gene for the cryptorchidism or ridgling character. None have yet been found which we are certain are free from this gene.

Initial crosses of horned stock Merino ewes have been made with polled Merino rams. This phase of the polled breeding project is cooperative with the Department of Animal Husbandry, School of Agriculture. One of the rams used in these initial crosses was sired by a horned ram, his polled gene having been carried in through the maternal parentage only. This ram was also tested by breeding to known mothers of ridglings from our grade polled Rambouillet stock. Among eight male lambs from this test two were double ridglings. This indicates that the cryptorchid or ridgling recessive pair of genes found contaminating polled Rambouillet stocks is the same as that found in some polled Merino stocks. Further tests to separate out non-carriers in both breeds are in progress, with the expectation that ridgling-free strains of polled Rambouillets and polled Merinos will result.

B. L. Warwick, J. M. Jones, W. H. Dameron,
P. B. Dunkle and A. K. Mackey.

Inheritance of the Ridgling Characteristic in Goats

Previous breeding over four seasons had pointed to the probability that one normal stud buck in the registered Angora flock was free from the

recessive ridgling genes. Further testing of this male has produced two ridglings in the 1938 registered kid crop, which shows definitely that he is heterozygous for at least one of the recessive pairs of genes for ridgling in goats. There can be little doubt that he carries a more favorable genotype than the most if not all of the other bucks tested. Seven normal male progeny with no ridglings were produced from this buck in the ridgling-bred test flock. Three bucks have only normal male progeny in the registered flock of Angoras, but their numbers are yet too few to know whether they are free from the ridgling genes.

B. L. Warwick.

Inheritance of Type in Angora Goats

An attempt has been made to revise the classification of mohair locks and to bring together an adequate set of samples for use in recording the changes from season to season on the same animal. The greatest difficulty has been experienced in adequately designating the type of any particular animal as there is a marked irregularity in type of lock in different seasons. Part, at least, of this irregularity seems to be due to the heterozygosity of the animals for the genes having to do with flat and ringlet types of locks. For these reasons, it has not yet been possible to analyze the segregation by types with enough definiteness to get any estimate of the genes concerned. Rigid selection for flat lock type and for ringlet lock type respectively without too great emphasis on other qualities for several generations should supply breeding material which would be more useful than any now available. This should be suitable both for comparison of the quality of mohair in the two types, and for critical genetic analysis. Very definite improvement in quality of fiber, as indicated by diameter of fiber, has been reached in the Station flock by selection.

J. M. Jones, B. L. Warwick, S. P. Davis, W. H. Dameron.

A Study of the Inheritance of Skin Folds on Rambouillet Sheep

(In cooperation with Bureau of Animal Industry,
U. S. Department of Agriculture)

Besides study of segregation in matings of pure-bred Rambouillets, matings have been made of one heavy C type and one B type Rambouillet ram to Corriedale ewes (free from wrinkles). The F_1 progeny have been raised and examined after the first fleeces were removed. Twenty-six have been studied in detail. In every case the number and size of the skin folds was smaller than recorded for the size when his first fleece was removed. Compared with their sire as 100, they range from 1 to 68 in values, with only three individuals having values above 50, the highest being 68. More than half had values of less than 20. This points to there being some dominance of the genes for freedom from skin folds. A few back-cross individuals have been raised, but more are needed before they

may be used for genetic analysis. The results so far point to the possibility that the number of genes may be relatively small.

J. M. Jones, B. L. Warwick, W. H. Dameron,
S. P. Davis, H. C. McPhee, D. A. Spencer.

Relation of Age of Animal to Fineness of Wool and Mohair

Data from the Rambouillet wool samples from the Ranch Station have been analyzed along similar lines to that previously published for mohair in Bulletin No. 516, and is nearly ready for publication.

J. M. Jones, B. L. Warwick, S. P. Davis, W. H. Dameron.

The Inheritance of Fiber Characteristics in Rambouillet and Romney Sheep and Their Crosses

This project, started last year, has for its primary purpose the study of the inheritance of staple length, together with the transference of some additional staple length to the Rambouillet breed from the Romney. The F_1 lambs have been raised and the F_1 males selected for further breeding. It was found that the pure-bred Romney lambs, born in March, were unable to withstand the prolonged heat at College Station without shearing. The F_1 lambs were affected to a less severe extent, while no losses occurred from this cause in the Rambouillets. These Romney, Rambouillet and F_1 lambs were raised parasite-free in a well-ventilated shed. The Romneys have less heat regulating ability than do the Rambouillets. The stud Romney ram used was also tested by breeding to black ewes and found to be a carrier of a recessive gene for black. The other Romney ram was sterile during the summer and early fall, in both 1937 and 1938, but recovered his fertility by early winter each year.

Records based on lengths of staple grown during a limited period of time appear to be suitable for selection and comparison purposes. The F_1 staple lengths are intermediate.

B. L. Warwick, S. P. Davis.

Feeding Problems Affecting Beef Production

U. S. Field Station, Big Spring, Texas

(In cooperation with Bureau of Animal Industry and Bureau of Plant Industry, U. S. Department of Agriculture)

The 170-day feeding test conducted during the 1937-38 feeding season with 40 good to choice Hereford steer calves that averaged 486 pounds at the time of being placed on feed, was, with some modifications in the plan of procedure, a continuation of work previously started to determine the efficiency of feed utilization by feeder steer calves, fed singly and in groups, (1) when full-fed, and (2) when fed limited rations. This investigation also includes a study of the relationship of type and individuality

of steers to rate and economy of gains. In the current test, the grain portion only was limited to approximately 80 per cent of that supplied to the full-fed steers. Cottonseed meal and silage were to be fed at similar levels for all lots.

The steers full-fed individually in Lot 1 utilized their feed slightly more efficiently than Lot 3, full-fed as a group. On the other hand, the limited grain steers, fed individually, Lot 2, were slightly less efficient in their feed utilization than Lot 4, limited group-fed, in feed requirement per 100 pounds of gain, basis feedlot weights. There was less variation in feed utilization and gains between individuals than in similar tests conducted previously.

In a comparison between Lots 1 and 2, fed individually, the latter (fed limited grain) consumed approximately 15 per cent less threshed milo and made approximately 9 per cent less gain. In a comparison between Lots 3 and 4, group-fed, the latter, fed limited grain, consumed approximately 18 per cent less milo and gained about 6 per cent less than the full-fed group.

In a comparison of individual and group feeding, Lots 1 and 3, full-fed, the latter lot, group fed, gained 5 pounds more per head and consumed 22 pounds more milo, 1 pound more cottonseed meal, but 3 pounds less silage per 100 pounds of gain. Comparing the limited grain-fed cattle, Lots 2 and 4, the latter lot, group-fed, gained 14 pounds more per head and consumed 9 pounds less milo, 3 pounds less cottonseed meal, but 30 pounds more silage per 100 pounds of gain than the Lot 2 cattle, fed individually.

Determinations of the physical and chemical composition of the 9th-11th rib cuts, Lots 1 and 2, definitely indicate that the carcasses from the full-fed animals had slightly higher finish. Physical separation showed that the rib cuts from the full-fed group, Lot 1, contained a slightly lower percentage of lean but a higher percentage of fat and total edible meat than Lot 2. The chemical analyses showed that Lot 1 (full-fed) contained a slightly lower percentage of protein and water but a higher percentage of ether extract. The marbling also was more complete in the eye muscles of the full-fed group.

A urinary bladder or urethral calculi condition developed in this group of steers during the course of the feeding period. Eight head of those individually fed showed pronounced symptoms of this condition during the feeding period. One steer in Lot 2 died as a result of this condition. An examination of these cattle by the Division of Veterinary Science at the time of slaughter revealed that most of the steers showed this calculi condition in varying degrees.

J. M. Jones, F. E. Keating, J. H. Jones.

Vitamin A Requirements for Beef Cattle and Sheep

(In cooperation with the Bureau of Animal Industry,
U. S. Department of Agriculture)

Experiments on this project are conducted at Substation No. 7, Spur, and are reported under that station.

Fattening Yearling Steers on Silage, Cottonseed Meal, Cottonseed Oil, and Cotton Seed

Experiments on this project are conducted at Substation No. 7, Spur, and are reported under that station.

Beef Cattle Feeding Investigations Relating to Mineral Deficiency Studies in Range Beef-Cattle Production

(In cooperation with Divisions of Chemistry and Veterinary Science,
and Bureau of Animal Industry, U. S. D. A.)

A mineral feeding experiment with range cattle, conducted cooperatively by the Bureau of Animal Industry, the Texas Agricultural Experiment Station, and the King Ranch, was begun in Brooks County on January 27, 1938. One hundred head of heifers were lotted into four groups of 25 head each. All heifers utilize the same range and water supply and are hand-dosed six days a week as follows: Group 1, no supplement; Group 2, raw bone meal to give 15 gms. P_2O_5 per head per day; Group 3, di-sodium phosphate to give 15 gms. P_2O_5 per head per day; Group 4, raw bone meal as in Group 2 and 160 mgms. Fe, 100 mgms. Mn, 15 mgms. Cu, 15 mgms. Co, 15 mgms. Bo, and 15 mgms. Zn per head per day. Individual weights are taken at 28-day intervals. Average weight gains for the 308 days of the experiment to date are: Group 1, 214.6 lbs.; Group 2, 297.2 lbs.; Group 3, 326.9 lbs.; Group 4, 303.2 lbs. The inorganic phosphorus content of blood samples from five heifers of each group is determined at 14-day intervals. The average inorganic phosphorus content in mgms. per 100 ccs. of blood for all samples collected to date are: Group 1, 3.2; Group 2, 4.9; Group 3, 5.0; Group 4, 5.1. Samples of the vegetation in the pasture are collected periodically for chemical analysis. The analyses of these samples indicate that a serious phosphorus deficiency exists in the area.

J. M. Jones, W. H. Black, L. H. Tash, and J. H. Jones.

Mineral Requirements of Cattle in the East Texas Region

Substation No. 2, Tyler, Texas

The last beef cattle (steers) were marketed from the Tyler station in December 1937 and the work is being continued with dairy cattle under the supervision of the Division of Dairy Husbandry.

It is possible that sufficient information was obtained in the four years steers were grazed at this Station for a bulletin concerning the gains of steers on East Texas pasturage; however, the information concerning mineral requirements of the region is not sufficiently complete for a bulletin but may be used in connection with the data to be gained from the dairy cattle.

J. H. Jones, P. R. Johnson.

A Study of Native and Improved Pastures in the Gulf Coast Prairie of Texas

Substation No. 3, Angleton, Texas

The division participated in this project from April 1934 to December 1937, and has assisted in the preparation of a bulletin "Pasture Improvement in the Gulf Coast Region of Texas," which will become available early in 1939.

J. H. Jones, R. H. Stansel and J. M. Jones.

Lamb Fattening Experiments

Substation No. 16, Iowa Park, Texas

Lamb fattening experiments begun at this station in November 1932 have been resumed with the purchase of 120 feeder lambs in October 1938. The present work includes a comparison between ground and shredded grain sorghum heads and between alfalfa hay and sudan hay in fattening rations. The lambs are being hand fed, which method of feeding is believed to be adapted to that section of Texas.

J. H. Jones, L. E. Brooks, J. M. Jones.

Accuracy of Small Wool Samples for Shrinkage Tests

Work was continued on this problem during 1938. This year's data were obtained from 53 fine twelve months fleeces from the Ranch Experiment Station flock, and 121 fleeces from five different ranches also in Southwest Texas. In addition, 52 fleeces of spring fine eight months wool from five Bandera County flocks were scoured, and the data analyzed.

The method of selecting the small sample from each individual fleece remained unchanged. This was done by taking a large handful of wool from the shoulder area of each animal at the time of shearing. The samples and corresponding fleeces received identical treatment in scouring and weighing.

This year's results compare very favorably with those obtained in 1937. The correlation between 53 Ranch Experiment Station twelve months fleeces and their corresponding small samples was $+0.86$ as compared with $+0.90$ for 199 fleeces from the same source in 1937. The correlation for all 1938 twelve months fleeces was $+0.90$. This indicates that the same

relation exists between the shrinkage of the small sample and the entire fleece from wool grown in different areas. The correlation from similar data on 52 eight months fleeces was $+ .96$.

At the start of this work it seemed advisable to make a study of individual fleeces in order to obtain basic data. Since the problem is to obtain accurate shrinkage figures on wool from entire flocks, it is one of the composite rather than individual samples.

This year's data were figured on a basis of both individual fleeces and individual flocks. Treatment of the data for individual flocks was accomplished by computing the means of the small samples and entire fleeces for each flock. This does away with the variation existing among individual fleeces leaving only variability due to differences between wools from various flocks. When the data were grouped in this way the standard deviation on twelve months fleeces was reduced from ± 4.53 to ± 1.88 , and from ± 5.06 to ± 2.09 for the shrinkage per cent of the whole fleece and the shrinkage per cent of the small sample respectively. In the eight months wool the standard deviations were reduced from ± 5.31 to ± 3.17 , and ± 6.38 to ± 3.87 for the shrinkage per cent of the whole fleece, and the shrinkage per cent of the small sample respectively. This grouping of individual fleeces does not materially affect the correlation. This correlation for 1938 twelve months wool, when grouped, is $+ .92$ as compared with the above figure $+ .90$ for individuals. For the eight months wool the correlation for the grouped was $+ .98$, and for individuals $+ .96$.

These figures indicate that by scouring small samples from any flock a very close estimation of the shrinkage percentage of an entire clip may be made. It is necessary, however, that data from a large number of flocks be secured in order to obtain increased reliability.

S. P. Davis, J. M. Jones, B. L. Warwick.

ENTOMOLOGY

Biology, Control, and Taxonomy of *Phyllophaga* White Grubs in Texas

Life history studies on *Phyllophaga* white grubs were continued during the year. Twelve economic species were included for records on development under laboratory and cage conditions in the field. It was found that in the laboratory white grubs developed satisfactorily within soil contained in 4-, 6-, and 8-ounce ointment boxes with grapenuts added as the sole source of food. Approximately 1400 white grubs were reared on this diet; most of the individuals, which hatched prior to May 15, attained full growth during September and October. After this time development ceased, and it appears likely that pupation will not occur generally until temperatures in late winter or spring are favorable. Two exceptional records of development from egg to adult in a single season are of interest; two larvae, (one *Phyllophaga hirtiventris* and one *P. crassissima*) which hatched on May 18-19, pupated on September 27-28, and emerged as

adults on October 19 and 23. It was also noted that the incubation period of the egg in some species may extend upwards of 50 days during cool weather in the early part of the active season. Descriptions of seven new species and four new subspecies with genitalic illustrations have been completed and submitted for publication.

H. J. Reinhard.

Boll Weevil

(In cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. D. A.)

Boll weevils (*Anthonomus grandis* Boh.) caused more damage in the West-Central and Northwest portions of the State than ever before. They were recorded as causing damage near Midland in West Texas and in Dickens County of Northwest Texas. The heavier rainfall was largely responsible for the spread and increase. In Northeast Texas only slight damage occurred late in the season on late planted cotton or on that planted on bottom lands. Unusually dry weather during July and August retarded the infestation in most areas. In South-Central Texas severe damage was spotted and confined mostly to bottom lands and small fields in wooded areas.

F. L. Thomas, et al.

Control: In the presence of a maximum weevil infestation of 30 per cent, no significant differences in infestations or yields were obtained with three different calcium arsenates containing low, medium and high water soluble arsenic pentoxide.

J. C. Gaines.

Hibernation: Ten lots of 500 boll weevils each were installed at College Station in separate hibernation cages at weekly intervals from October 2 to November 13, 1937, for records on winter survival. During the following spring removal of the active weevils from the cages was begun on April 1, about one week after young cotton plants first began to appear in local fields. Spanish moss was used as shelter material.

A total of 336 weevils or 6.72 per cent of the 5000 individuals installed passed the winter successfully. The minimum dormant season temperature was 25 degrees F. recorded in December 1937 and January 1938. Total weevil emergence from hibernation by months was as follows: April, 2.54 per cent; May, 3.44 per cent; June 0.74 per cent. Final emergence was recorded on June 20.

H. J. Reinhard.

In Northeast Texas, near Tyler, similar installations of 1500 weevils were made with crab grass as shelter. A survival of 1.20 per cent was recorded in 1938 as compared with 9.21 per cent in 1937.

W. L. Owen, Jr.

On October 15, two cages containing 500 weevils each were installed at the Winter Haven Substation in Dimmit County. One contained the typical woods-rat nest material, the other had corn as shelter for the weevils. Survival in each case was .6 per cent. The weevils emerged during March and early April.

S. E. Jones.

As in past years, 35,000 weevils were used in hibernation experiments by the Bureau of Entomology and Plant Quarantine. Emergence was recorded May 2 to June 30, 1938. The survival of weevils which had overwintered in different types of shelter material was 1.96 per cent from corn stalks in the open, 5.69 per cent from moss in the open, 7.24 per cent from moss in the woods, 10.24 per cent from leaves in the woods.

Total emergence was 4.51 per cent.

R. W. Moreland.

Cotton Flea Hopper

Comparatively light damage was caused by the cotton flea hopper (*Psallus seriatus* Reut.) in Texas in 1938.

Varietal Resistance: Infestation in two locations was too low to obtain results other than those showing trends or indications. Besides infestation records another method is being utilized for measuring the differences in varietal resistance of cotton. By controlling the flea hopper on one-half of each variety resistance is measured in inverse proportion to the increase in yield of the dusted half over that of the untreated half of each variety.

F. L. Thomas, J. C. Gaines, and M. J. Janes.

Strip Planting: There were no significant differences in the infestations found on rows of cotton near to or somewhat removed from strips of corn or sorghum, although in most cases the fifth and tenth rows produced more cotton than did the fifteenth and twentieth rows.

Relation to Previous Crops: Although examinations in the work were made under conditions of low infestations, it appears that the thrifty, more succulent cotton following oats may attract the flea hopper in greater numbers than cotton following corn or cotton, especially where the land was enriched by plowing under stubble or volunteer oats.

W. L. Owen, Jr.

Migration and Population: The first adult hopper was taken March 25. The movement from weed fields to cotton was at its maximum during the first week in May and the population in local fields reached a peak of 31 adult hoppers per screen trap during the latter part of June.

In Northwest Texas in the vicinity of the Spur Substation, activity was most pronounced during the first three weeks in July. Wind direction as indicated by balloon drift was from southeast to northwest below the cap

rock, indicating that the source of flea hopper infestation that occurs in the vicinity of Crosby and Lubbock Counties and those just below the cap rock may be in the weeds of the rough broken lands to the southeast.

J. C. Gaines and F. L. Thomas.

Control: An infestation of only 20 flea hoppers per 100 terminals which dropped the following week was not sufficient to show profitable control. One application was made.

Control tests conducted in Dickens County with sulphurs having different degrees of fineness showed increases in yields of 98, 280, and 377 pounds of seed cotton per acre when the flea hopper infestations on the untreated blocks were as much as 60 per 100 terminals. Four applications were made and a ground sulphur appeared even more effective than a microscopic type. This was also supported by control tests in Kaufman County, where the infestation was reduced more effectively by means of ground sulphur than with the microscopic type.

J. C. Gaines, W. L. Owen, Jr., and W. S. McGregor.

Hibernation: Among the various weed host plants that are known to carry cotton flea hopper eggs through the winter, *Croton capitatus*, commonly known as goatweed, is preferred wherever it commonly occurs. To secure records on emergence of young flea hoppers in the spring, eleven lots of 100 *C. capitatus* plants were collected during November 1937 in Brazos and seven adjoining counties.

The eggs contained in these plants began to hatch on February 27, as compared with February 18 during the previous season. The seasonal accumulative emergence recorded at biweekly intervals was as follows: Mar. 1-15, 2.53 per cent; Mar. 16-31, 60.43 per cent; Apr. 1-15, 86.12 per cent; Apr. 15-30, 95.68 per cent; May 1-15, 99.13 per cent. An average of 4352 flea hoppers was recorded per 100 *Croton capitatus* plants. This was about 76 per cent of the normal emergence.

H. J. Reinhard.

In Northeast Texas similar installations of *Croton capitatus* collected in Smith, Van Zandt, and Wood Counties were made at the Tyler Substation, and an average of 9,128 flea hoppers was recorded per 100 weeds. Emergence from the weeds collected in Smith County averaged 14,533, 99 per cent of which occurred before the end of April.

W. L. Owen, Jr.

Pink Bollworm

(In cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. Department of Agriculture)

The most important development of the pink bollworm (*Pectinophora gossypiella* Saund.) situation in 1938 was its spread out of the Lower Valley, two years after discovery of the worms, to four counties in the

vicinity of Corpus Christi. The increasing numbers in the Lower Valley provide a serious and alarming threat to the remainder of the Cotton Belt. It is important that reliable information regarding the activities of this insect in South Texas be obtained as soon as possible.

F. L. Thomas.

The bloom infestation counts during June and the boll records during August showed that the pink bollworm infestation was higher in the Presidio Valley in 1938 than in the past several years. The increase in the infestation can be attributed to several factors. Preparations for the 1938 crop were started later than normally, and the stalks on most of the acreage planted to cotton were turned under in the late winter, while those in the retired fields were left standing. There was a heavy population of pink bollworms overwintering on the stalks in some of the fields, and since the winter was unusually mild this contributed to a good carry-over. Volunteer cotton was more plentiful this year than ever before, due to the mild winter and the large acreage of retired cotton land. This volunteer cotton was fruiting and breeding up pink bollworms several weeks ahead of the planted cotton, and these moths later on migrated to the cultivated fields.

In the studies conducted with various cotton varieties some of the quick maturing eastern varieties again gave greater yields and better grades and staple than the slow maturing varieties. The varieties with a small open type plant with a determinate growth appeared to be better adapted to escape pink bollworm injury than the varieties with a rank growth. A date of planting experiment showed that a wide spread in the time of planting, especially in fields that are not widely separated, results in much more severe pink bollworm damage to the late planted cotton.

Breeding and colonization were continued with the three introduced parasites, *Microbracon kirkpatricki*, Wilk., *Chelonus blackburni*, Cameron, and the Hawaiian strain of *Microbracon mellitor*, Say. The three species were liberated but as yet definite information has not been obtained as to whether or not they have become established. None of the introduced parasites were recovered in hibernation cages from infested cotton bolls that were collected from last year's points of liberation. There was, however, a heavy emergence of native parasites from this material. Colonies of *Microbracon kirkpatricki* were also liberated in the boll weevil area since this parasite has been found to attack the weevil. The breeding and colonization of *Microbracon kirkpatricki* was discontinued after the releases were made this year as sufficient numbers of this species have been liberated for probable establishment.

In field plat insecticide tests both Cryolite and barium fluosilicate dusts gave some reduction in the percentage of bolls infested and a significant reduction in the number of worms per infested boll. These tests further indicated that the degree of control is dependent upon the extent of boll

coverage with the insecticide. In controlled field cage tests phenothiazine gave sufficient reduction in the infestation to justify trials.

A. J. Chapman.

Cotton Bollworm

(In cooperation with the Bureau of Entomology and Plant Quarantine,
U. S. Department of Agriculture)

Hibernation and Spring Emergence: A little over 25 per cent of hibernating pupae of *Heliothis obsoleta* Fab. produced moths in the spring of 1938. This is the highest spring emergence recorded during the eight years hibernation experiments have been carried on. The average spring emergence is slightly over 3 per cent.

Biological: The first increase of eggs on cotton occurred about July 9. Again, as in 1937, the greatest increase in oviposition was on cotton with the highest per cent of total moisture in the growing tops, showing the attractiveness of succulent cotton to ovipositing moths.

Natural Control of Eggs and First Instar Larvae: Over 400 eggs laid on cotton plants were tagged and notes taken daily. Even on cotton with a count of 90 eggs per 100 terminals less than 10 per cent of the plants showed subsequent injury. An hemipterous insect *Orius insidiosus* (Say) and lace wing fly larvae were the most important predators on eggs. Over 90 per cent of the eggs were destroyed by these and other causes. Observations were made on 105 first instar larvae on cotton. Some larvae were watched continuously while records were made on others at short intervals. *Orius insidiosus* was observed to destroy about 20 per cent of the larvae. In 75 per cent of the cases where larvae disappeared, *O. insidiosus* were present. Spiders and lace wing fly larvae destroyed many bollworms. Some larvae died before they could find suitable food, while other larvae dropped from the plants and were lost.

R. K. Fletcher.

Control: Calcium arsenates containing low, medium, and high arsenic pentoxide, and mixtures of the medium type with Paris green or with small amounts of As_2O_3 , showed no differences in the control of the cotton bollworm when applied 8 to 9 pounds per acre and in the presence of 18 per cent damage in the untreated cotton.

J. C. Gaines.

Thrips on Cotton

Thrips (*Frankliniella tritici* Fitch) generally were considered to be injurious due to the dry spring. In some cases losses in stands of cotton were observed although records indicated the insects were not as abundant as in previous years. Thrips occurred in greatest numbers in cotton during the third week in April.

J. C. Gaines.

Cotton Leafworm

Control: In toxicity tests upon *Alabama argillacea* Boh. a calcium arsenate containing a high water soluble arsenic pentoxide was found to be about twice as poisonous as a calcium arsenate containing a low water soluble As_2O_5 .

J. C. Gaines.

Sulphur as an Insecticide

(In cooperation with the Texas Gulf Sulphur Company
and the Freeport Sulphur Company)

Progress in this project is reported elsewhere under Truck Crop Insect Investigations, and Substations No. 15 and 19; also under Cotton Flea Hopper.

Pecan Insect Investigations

(In cooperation with School of Agriculture, A. & M. College of Texas)

The search for an effective material to control the pecan nut case bearer (*Acrobasis caryae* Grote) while in its overwintering hibernaculum was continued.

A proprietary spray oil containing 96 per cent oil and 4 per cent dinitro-cyclo-hexylphenol applied at 300 to 350 pounds pressure produced 89 to 100 per cent control at concentration of 2 to 4 per cent.

The effect of these sprays at 300 to 350 pounds pressure was tested during February on the leaf case bearers (*Acrobasis palirolella* Rag.) on trees 50 to 70 feet high. A high degree of control was obtained but also there was some tree damage from the spray oil.

S. W. Bilsing.

Devil's Shoestring, *Tephrosia virginiana* (Linn.), as an Insecticide

(In cooperation with the School of Agriculture, A. & M. College of Texas,
and the Bureau of Plant Industry, U. S. D. A.)

The work has been continued along the same lines for the past two years. Considerable more data have been compiled upon seasonal and annual variation of the rotenone content of individual plants. The rotenone content for the past year was found to be the greatest during late summer and early fall. The total carbon tetrachloride extract is correlated with the rotenone content. Samples have been analyzed containing an excess of 5 per cent rotenone.

Several inbred lines have been established. Field selection is also being continued. Rotenone is inherited, but it is not known to what extent at this time.

Development of cultural and harvesting practices is progressing. Present indications are that an annual yield approaching 500 pounds per acre may

be expected without destroying the plants, thus making the planting permanent.

V. A. Little, G. A. Russell (Bu. Pl. Ind.).

Truck Crop Insect Investigations

The work has been conducted at three locations: the Laboratory in Galveston County and at Substations 15 and 19. Reports of progress at the Substations will be found under Substation numbers.

Turnip louse (*Rhopalosiphum pseudobrassicae*): Promising results have been obtained in control of this pest by means of a pyrethrum-sulphur dust containing one-tenth of one per cent pyrethrins and also with a rotenone-sulphur dust containing .4 per cent rotenone when temperatures are 60° F. or higher.

Flea beetle (*Phyllotreta vittata discedens* Weiss): A rotenone-sulphur dust containing .4 per cent rotenone was more effective in preventing damage on turnips than pyrethrum-sulphur mixtures.

Hawaiian Beet Webworm (*Hymenia fascialis* Cramer): Pyrethrum-sulphur mixtures containing one-tenth of one per cent pyrethrins were satisfactory in controlling this pest, but mixtures with less than this percentage were not as effective.

Tomato Fruitworm (*Heliothis obsoleta* Fab): Alorco Cryolite and sulphur 50-50 produced as good control as calcium arsenate. Damaged fruit on the dusted plats was 4 to 6 per cent, while on the untreated it was 26 per cent.

J. N. Roney and M. J. Janes.

For additional information on truck crop insect investigations see reports of Substations 15 and 19.

Citrus Insect Investigations

Work under this subject is presented in the report of Substation 15.

Apiary Inspection

During the fiscal year 1937-38, 45,698 colonies of bees were inspected. Of this number 309 colonies or .68 per cent were infected with American Foulbrood. The inspectors visited 730 beekeepers in 77 counties. In five of the latter, inspection work was done for the first time.

The present status of American Foulbrood in Texas shows that infection has been less than one per cent during the last five years.

Certificates of inspection were issued to 36 queenbreeders and package bee shippers.

C. E. Heard and C. J. Burgin.

AGRONOMY

Fertilizers for Field Crops

Experiments with fertilizers are being conducted on several crops at the Main Station and some of the substations to determine the fertilizer needs of the crops on different soils. In 1938 the work was conducted at College Station, Angleton, and Tyler.

Cotton is included in the experiment at all three points. The yields of the several treatments at College Station in 1938 were considerably larger than the average yields for the 12 years 1927-1938. Of the 17 fertilizer treatments used, the application of 12 tons of manure per acre made the largest yield, 572 pounds of lint per acre, or more than double the yield of 280 pounds for the untreated soil. The application of a 4-12-0 fertilizer at the rate of 400 pounds per acre made the lowest yield (272 pounds) in 1938 and the lowest average yield for the 12 years. During this period the treatment consisting of 12 tons of manure and 400 pounds of superphosphate per acre produced the largest average yield, 377 pounds of lint per acre, which was 157 pounds, or 71 per cent, more than the yield of 220 pounds from the unfertilized soil. The increase in yield of lint resulting from the manure used at the rates of 8 and 12 tons per acre has been worth on the average \$8 to \$12 a year, making a return of about \$1 per acre a year for each ton of manure. The results of the experiment at College Station during the 12 years show that the Lufkin fine sandy loam, on which the work was conducted, is more deficient in phosphoric acid and potash than in nitrogen. The use of 300 to 400 pounds of a 4-12-4 fertilizer is good fertilizer practice for cotton on the Lufkin soils.

At the Angleton station, located on Lake Charles soil, the yields of cotton obtained from the several fertilizer treatments were somewhat lower in 1938 than the average yields during the last seven years. Of the 22 different fertilizer treatments in the experiment, the 0-12-4 fertilizer made the lowest yield, 309 pounds of lint per acre in 1938. The yields, however, ranged up to 451 pounds per acre for the 4-12-0 fertilizer. During the seven years of the experiment the treatment of 800 pounds per acre of an 8-12-8 fertilizer made the largest average yield, 500 pounds of lint per acre, which is 190 pounds or 61 per cent more than the yield from the unfertilized soil. The average yields of cotton increased as the amount of nitrogen was increased, as the phosphoric acid was increased up to 8 per cent, and as the amount of fertilizer was increased from 200 to 1000 pounds per acre. The results as a whole show that the soil is deficient in phosphoric acid and nitrogen. From a practical point of view, moderate applications (400 to 600 pounds per acre) of a 4-8-0, 4-10-0, or 4-12-0 fertilizer is profitable fertilizer practice on the prairie soils of the Gulf Coast. The use of concentrated fertilizers such as 16-20-0 at 200 pounds per acre also should be profitable.

The experiment at Tyler is somewhat different from those at College

Station and Angleton and the results will be found in the report of Substation No. 2, Tyler.

The results of these fertilizer experiments with cotton are being prepared for publication as a bulletin of the Station.

Corn is grown in the fertilizer experiment at College Station, Angleton, and Tyler. At College Station in 1938 the yields were about normal or approximately the same as the average yields during the 12 years 1927-1938. The highest yield, 34.2 bushels of shelled corn per acre, was obtained from the plats that received 8 tons of manure per acre. This yield was more than double the yield of 15.1 bushels from the unfertilized soil. During the 12 years of the experiment, however, the treatment of 12 tons of manure and 400 pounds of superphosphate per acre produced the highest average yield, 30.8 bushels per acre, or 44 per cent greater than the yield of 21.3 bushels from the unfertilized land. The results of the experiment to date indicate that moderate applications of fertilizer, 200 to 400 pounds of a 4-12-4 or 4-8-4 fertilizer per acre, is satisfactory for corn on the Lufkin soils. The use of liberal amounts of farm manure also is good practice.

At Angleton in 1938 the yields of corn were slightly higher than the average yield for the eight years 1930-1938. The largest yield in 1938 (51.3 bushels per acre) was obtained from the soil that received 800 pounds of a 10-12-4 fertilizer per acre. This yield was 22.9 bushels, or about 80 per cent more than the yield of 28.4 bushels per acre from the untreated soil. The 10-12-4 fertilizer also made the highest average yield, 39.6 bushels per acre, for the 8-year period. In general the average yield of corn increased as the amount of nitrogen and as the rate of application of fertilizer was increased. The results of the experiment for the 8-year period, however, indicate that 200 to 400 pounds of a 4-8-0 or 4-10-0 fertilizer is satisfactory fertilizer practice for corn on the dark prairie soils of the Gulf Coast.

The results of the fertilizer work with corn at Tyler are given in the report of Substation No. 2, Tyler.

The complete results of the stations are being prepared for publication.

Oats are included in the fertilizer experiment at College Station only. In 1938 most of the fertilizers increased the yield of oats to some extent. The treatment of 600 pounds per acre of a 4-12-4 fertilizer made the largest yield, 40.2 bushels, as compared with 25.2 bushels for the untreated soil. During the 11-year period, 1928-1938, however, fertilizers have not increased the yield of oats enough to return a profit.

E. B. Reynolds.

Hairy Vetch as Green Manure for Cotton

The object of this experiment is to determine the value of hairy vetch as a soil-improving crop for cotton and especially to ascertain if the vetch when plowed into the soil in the early spring will add enough nitrogen to the soil for the following crop of cotton. The test was started several years ago at College Station, Nacogdoches, and Tyler. This statement reports the results obtained only at College Station. The reports of the work at the other points will be found in the reports of the sub-stations concerned.

At College Station four treatments and unfertilized soil are used: (a) vetch alone, (b) vetch and 0-8-4 fertilizer, (c) vetch and 4-8-4 fertilizer, (d) 4-8-4 fertilizer, and (e) unfertilized soil. The fertilizer was used at the rate of 500 pounds per acre. The treatment of vetch and 0-8-4 fertilizer made the largest yield in 1938, 395 pounds of lint per acre. The soil on which unfertilized vetch was plowed under and the untreated soil produced almost identical yields, 280 and 281 pounds per acre, respectively. During the two years 1937 and 1938, the treatments of (1) vetch and 0-8-4 and (2) 4-8-4 fertilizer produced the same average yield, which was 331 pounds of lint per acre. The soil on which unfertilized vetch was plowed under made an average yield of 257 pounds of lint for the two years as compared with 233 pounds on the unfertilized soil. These results indicate that the soil is first deficient in phosphoric acid.

In these studies the amounts of vetch plowed into the soil was determined. During the two years the fertilized vetch produced an average yield of 2831 pounds of water-free vegetable matter and the unfertilized vetch, 2070 pounds. The amounts of nitrates in the soil resulting from the decaying of the vetch were determined at intervals of two weeks during the growing season of cotton in 1937 and 1938. In general the soil on which vetch was plowed under contained about twice as much nitrate nitrogen as the untreated soil or the soil which received 500 pounds of the 4-8-4 fertilizer. This fact showed that the vetch added much more nitrogen to the soil than the cotton plants could use to advantage. These results indicate that vetch fertilized with superphosphate and plowed into the soil is fully as effective as a complete fertilizer.

E. B. Reynolds.

Comparison of Different Nitrogenous Fertilizers

This experiment is conducted to determine the relative merits of different nitrogenous materials used as sources of nitrogen in commercial fertilizers. The work was conducted with eight different materials applied to cotton on Lufkin fine sandy loam soil at College Station in 1938.

In general the fertilizers did not produce significant increases in yield, probably due to the dry weather in July and August which caused considerable shedding. The soil treated with nitrate-limestone, however, pro-

duced 335 pounds of lint per acre as compared with a yield of 313 pounds from the unfertilized soil. During the seven years of the experiment, however, nitrate of soda and ammonium sulphate made the largest yields, 295 and 284 pounds of lint, respectively.

In connection with the test with nitrogenous fertilizers, a 4-8-4 fertilizer was applied 2 inches under the cotton seed and to the side and below the level of the seed. No significant difference in yield of cotton was obtained from the two placements.

E. B. Reynolds.

Polyhalite as a Potash Fertilizer

This work is conducted on Lufkin fine sandy loam at College Station to determine if polyhalite, a potash mineral in extensive deposits in western Texas, is a good source of potash for commercial fertilizers. In this experiment a 4-8-4 fertilizer is used at the rate of 400 pounds per acre in which the potash is supplied in muriate of potash, red polyhalite and white polyhalite. In 1938 no significant differences in yield of cotton were obtained from these materials. During the four years, 1933, 1935, 1937, and 1938, however, the soil treated with white polyhalite made an average yield of 327 pounds of lint per acre, or only 11 pounds more than the yield of the soil treated with muriate of potash. These average results indicate that the soluble potash in polyhalite is as readily available to the growing cotton plants as the potash in muriate of potash, which is the usual form of potash in commercial fertilizers.

E. B. Reynolds.

Inheritance in Cotton

(In cooperation with the Bureau of Plant Industry, United States
Department of Agriculture)

Studies on inheritance and linkage relations of various characters in cotton are yielding interesting and valuable results which are being utilized in breeding to improve the present varieties through a system of hybridization, backcrossing, and selection. The mode of inheritance of length of lint, percentage of lint, type of boll, seed fuzziness, and certain new leaf and lint colors in various new combinations have been determined. Some of these characters are of considerable economic importance and a knowledge of their relationship is proving of value in developing well-adapted, high-yielding strains of good quality staple that are more resistant to drought, insects, and diseases. The use of the greenhouse during the winter enables the growing of two crops of cotton in one year which has greatly facilitated the progress of the work.

The fiber fineness work now in progress involves crosses of the fine-fibered Hopi with commercial upland types, and a number of promising selections are now being studied. Crosses with Acala strains showed the greatest increase in vigor and productivity in the F₁, although crosses of

Acala and Delfos showed the greatest productivity in the first backcross generation grown during the year.

In the naked-lintless X covered lint-bearing crosses, results so far indicate that the naked seeded character definitely inhibits the amount of lint produced per seed (lint index). Several strains having naked seeds and various degrees of low lint index have been isolated. This study has an important relationship to the problem of developing types of cotton primarily for seed production.

Further studies of F_2 material substantiate conclusions of last year as to the independence of the genes for brown and green lint.

Boll apical furrow, which is a partial dominant to the absence of apical furrow, was studied further during the year. Two classes of furrow, giving dihybrid F_2 ratios, have been observed. The true breeding behavior of certain F_2 segregates was established, although it appears that environment as well as minor modifiers, affect the expression of character to some extent. Crosses of boll apical furrow with one of the synthetic lines, involving certain boll, lint, leaf, and seed characters, with virescent yellow leaf, and with Half and Half for pollen color have been made to test for linkage relationships between these characters and boll apical furrow.

The F_1 generation of crosses to study the inheritance of the hairy condition of the plant was grown during the year. Hairy types have been crossed with several high yielding, good staple commercial varieties lacking in hairiness with the view of introducing the hairy condition into these widely grown varieties so they can better retain the poison applied in insect control. The F_1 is slightly more than intermediate in grade, and quite uniform, the hairiness tending to approach that of the hairy parent. Selfed seed from the F_1 plants were obtained and backcrosses made for further study.

The fourth backcross generation in the study of the effect of leaf color and shape on yield was grown in 1938. The progenies are now 31/32 pure for the specific character being studied. Selfed seed of the various lines differing only by a single gene in the four gradations of leaf color and one of shape have been obtained. These lines will be increased to obtain sufficient seed to conduct a field yield test to determine the effect that color and shape of leaf have on yield.

The analysis of the genetic data on other characters being studied in 1938 has not been completed, and therefore the final results are not available at this time.

D. T. Killough, T. R. Richmond, R. E. Harper.

Cotton Variety Tests

(In cooperation with Bureau of Plant Industry, U. S. Department of Agriculture)

The regular tests with varieties of cotton were conducted at the Main Station and at the substations during the year. In addition cooperative variety tests were conducted jointly with the Bureau of Plant Industry, United States Department of Agriculture, at the Federal Stations at Greenville and Big Spring, and at the Chance plantation on the alluvial soils along the Brazos River near College Station. Variety tests also were conducted in Nueces and Young counties in cooperation with the Extension Service.

In October 1937 mimeographed Progress Report No. 472, giving information on yield, length, and percentage of lint; size of boll; and money value per acre of lint and seed of all varieties tested at the Main Station and the substations was published. This report has been given wide circulation and should prove helpful in selecting suitable varieties for the different sections of the State. The information should be of special interest to communities desiring to produce better quality cotton on the basis of one variety to the community. The recent report on varieties of cotton recommended for planting in standardized variety communities and areas throughout the State, issued by the Statewide Cotton Committee of Texas, was based on the data in Progress Report 472 and other data of the State and Federal experiment station tests, on data from the spinning laboratory of the Bureau of Agricultural Economics, U. S. Department of Agriculture, and on other information on varieties of cotton commonly grown in Texas.

In general the early maturing types of Triumph and Mebane, and strains of Lone Star and Acala have shown a wide range of adaptation in the State and continue to give good results. The Rowden types are well suited to central and eastern Texas. The longer staple varieties such as Acala, D & P L 11A, Stoneville 2B, and the larger boll Delfos types have been the most profitable in the Gulf Coast Prairie, on the alluvial soils, and where cotton is grown under irrigation.

D. T. Killough and T. R. Richmond.

Cotton Improvement

The cotton improvement work is conducted in cooperation with the superintendents of the substations. The purpose is to develop higher-yielding varieties of good quality staple for given regions of the State. Straight selection and hybridization, followed by backcrossing and inbreeding are being employed in the work.

During the year a number of new selections were made and these will be grown in randomized and replicated tests to determine yielding ability and uniformity to type. Mebane 804-50 developed at Beeville, Mebane 96

and Lightning Express X Westex at Lubbock, Mebane 140 and 141 at Chillicothe, Mebane 804-36 at Angleton, Startex 619 at College Station, and Sunshine 74-2 and 83-3 at Denton continue to yield well in comparative tests with leading commercial varieties.

The eighth generation of the cross Lone Star with Half and Half was grown at Nacogdoches in 1938. Hybridization followed by backcrossing and inbreeding has been used since 1933 for the purpose of combining the good staple and boll qualities of Lone Star with the high yield, high percentage of lint, and earliness of Half and Half, with the view of developing a better variety for the region. During the last four years six of the 36 selected hybrid strains have shown definite superiority to the parents in yield and in certain boll and fiber qualities. These six strains were tested at Chillicothe in 1938 and three of them exceeded the yield of Half and Half and two early maturing strains of Mebane, which previously had been the high yielding varieties at that station.

In the breeding work particular attention is being given to length and quality of staple, as well as to yield, earliness, boll type, and resistance to insect damage and disease. Numerous crosses have been made to improve the staple qualities of several high-yielding strains and the results to date indicate that it is possible to increase the length and strength of the fiber and also retain other desirable qualities such as high yield, earliness, and high percentage of lint.

Seed of the improved strains of cotton developed by the Experiment Station are being increased as rapidly as possible on cooperating farms and some have been put into channels of commercial production through State certified seed growers and others so that the seed may be readily available to the farmers of the State.

D. T. Killough.

The Spacing of Cotton

In 1926, the complete results of extensive experiments on the spacing of cotton in different parts of Texas were published in Bulletin 340, "Effect of Spacing on the Yield of Cotton," and the work discontinued. Since that time, however, considerable demand has arisen for information on the proper spacing of cotton plants on soils of different degrees of fertility. In order to get some information on this phase of spacing, a test using 12-, 18-, and 24-inch spacings on land with three levels of fertility was begun at College Station in 1936. The three levels of fertility are obtained by using unfertilized soil, and soil treated with 400 pounds and 800 pounds per acre of a 4-8-4 fertilizer.

In 1938 the yield of cotton decreased as the spacing was increased. When the yields obtained from different levels of fertility are averaged, the 12-inch spacing produced 363 pounds of lint per acre; the 18-inch spacing, 331 pounds; and the 24-inch spacing, 321 pounds.

The fertilized soil produced decidedly larger yields than the untreated soil. Thus, the soil that received 800 pounds of fertilizer per acre yielded 377 pounds of lint per acre; the soil that received 400 pounds of fertilizer, 367 pounds of lint; and the untreated soil, 271 pounds.

During the three years of the test, 1936-38, the average yield of cotton also decreased as the spacing increased. The 12-inch spacing made an average yield of 253 pounds of lint per acre; the 18-inch spacing, 238 pounds; and the 24-inch spacing, 227 pounds. Considering now the different levels of fertility, the unfertilized soil produced an average yield of 185 pounds of lint per acre for the three years; the soil treated with 400 pounds of fertilizer, 254 pounds of lint; and the soil that received 800 pounds of fertilizer per acre, 280 pounds of lint. These results are in general agreement with previous results.

E. B. Reynolds.

Rice Improvement and Methods of Production Tests

(In cooperation with Bureau of Plant Industry, U. S. Department of Agriculture)

The investigations on rice are conducted mainly at the Rice Experiment Station at Beaumont. The work includes studies on breeding and selection of rice, testing of varieties and new strains developed, rates of seeding, various fertilizer practices, irrigation, and diseases. The results of these studies are given in the report of Substation No. 4.

E. B. Reynolds, R. H. Wyche, H. M. Beachell.

Breeding Cotton for Mechanical Harvesting

The breeding work to develop types of cotton better suited to mechanical harvesting than the commonly grown varieties was continued at College Station and Lubbock in 1938. Hybridization followed by backcrossing and rigid selection is being employed. The effect of different plant and boll characteristics on the harvesting qualities of the different varieties is being studied. It has been found that varieties with less vegetative growth and relatively large storm-proof bolls arranged in semi-cluster form on long thin peduncles were harvested more efficiently and with less trash by the Texas Station harvester than varieties that did not possess these characteristics.

The new improved Ducona developed by the Station has one of the most desirable plant types from the standpoint of mechanical harvesting of any other variety that has been tested. Continued inbreeding and selection have produced several uniform strains with branches of intermediate length and semi-cluster fruiting habit which are more productive and have a higher percentage of lint and larger and more storm-proof bolls than the original type of Ducona. In order to further improve these strains, crosses have been made with other varieties having certain

desired characters which the Ducona strains still lack. Two of the most promising hybrid strains are crosses between Ducona and Lone Star, and Ducona and Half and Half. The F₂ and backcross generations of these crosses were grown at Lubbock. Further selections were made which will be inbred to establish uniform strains with the characters desired.

A new variety known as Macha, with a boll of unusual storm-proof qualities, has been found at Lubbock by D. L. Jones. Crosses of Macha with other varieties and strains will be made to improve their storm resistance which is extremely important in harvesting by machinery.

The results of other phases of the project, including the efficiency of cotton harvesting machinery, developing of cleaning machinery, and cleaning and ginning mechanically harvested cotton are given in the report of the Division of Agricultural Engineering.

D. T. Killough, H. P. Smith, D. L. Jones.

Variety Test of Soybeans

During the last three years the test with varieties of legumes has been confined largely to varieties of soybeans for seed production at College Station, Beeville, Tyler, Angleton, and Denton. The work at College Station, which included 14 varieties planted at three different dates, was a practical failure in 1938. Mamredo and Manchu which produced 2.8 and 2.1 bushels of seed per acre, respectively, at the first planting (April 11), were the only varieties that produced any seed. Somewhat similar results have been obtained during the last three years.

In the test at Angleton in 1938, 16 varieties were planted at three different dates, but it was necessary to replant the test seeded at the second date of planting so that data on only two dates of planting (early and late) were obtained. Otootan made the largest yield (13.9 bushels per acre) at the first planting but the Avoyelles variety made the largest yield (10.6 bushels per acre) when the yield of the two dates of planting were averaged. For the three years 1936-38 Avoyelles, Otootan, and Mamredo, in the order named, made the largest average yield of seed, 3.9, 3.3, and 3.3 bushels of seed per acre. These yields are low, however, and indicate that soybeans on the average are not successful for seed production in the area.

Practically all the varieties in the experiments at Beeville, Denton, and Tyler failed to produce seed or produced only a small amount of seed in 1938. During the last three years, 1936-38, very low average yields of seed have been obtained at Tyler. Laredo made the highest average yield, which, however, was only 3.4 bushels of seed per acre. Laredo and Manchu seem to be the most consistent producers of seed. Practical failures have been obtained with all varieties at all planting dates at Beeville and Denton.

The results of the experiments with varieties of soybeans at these five points indicate that the present commercial varieties are not well adapted to seed production in Texas. Efforts will be continued, however, to secure varieties that will produce satisfactory yields in Texas. Some of the varieties, especially Laredo and Oootan, produce satisfactory yields of hay.

E. B. Reynolds.

Germination and Longevity of Bitterweed Seed

This project was conducted six years, 1931-36. During this period it was found that the germination of bitterweed seed harvested in May, 1931, declined from 72 per cent to less than one per cent. This work was discontinued after 1936 because the seeds stored in the open had deteriorated to such an extent that it was not possible to secure satisfactory samples for germination. It is planned to write up the results of this work at an early date.

E. B. Reynolds.

Inheritance and Improvement in Sorghum

Breeding work, with the object of developing resistant varieties of all of the better commercially important sorghums that are susceptible to *Pythium* root rot, has been continued with very satisfactory results. Resistant varieties of Dwarf Yellow milo, Standard Yellow milo, Double Dwarf Yellow milo, Early Yellow or Sooner milo, Early White milo, Darso, and Quadroon have been developed and either already distributed to farmers or are now in the process of distribution. Further trials with the many resistant selections of the above varieties will require several years to decide on which are the superior ones in all respects. In the meantime, since the scope and damage of milo root rot disease is increasing so rapidly, and resistant varieties the only solution, the best appearing selections have been increased and distributed. The seed supply now in the hands of Certified seed growers and farmers should, within another year, be adequate to replace entirely the susceptible varieties of milo. In 1938 at Chillicothe, Lubbock, and Spur, the new resistant Dwarf milo yielded 12, 13, and 44 bushels more to the acre, at the respective stations, than the old susceptible variety. Virulence of the disease was from moderate to severe but prevalent throughout the High Plains this year.

Sclerotium bataticola, or Charcoal rot, was, for the first time, found attacking sorghums extensively throughout the western part of the State. Decay in the lower stalk and lodging of the crop caused large losses. All sorghum varieties appear susceptible; however some selections were made in one strain that seemed to be more resistant than others adjacent.

Sudan grass breeding work, with the view of creating new strains having sweet, juicy and pithy stems, non-shattering seed habits, resistance

to foliage diseases, and marked with distinctive glume colors, is progressing rapidly. More than 150 plant rows of crosses between Sudan grass and Leoti sorgo and backcrosses from three to five times with the Sudan parent, were grown in the nursery for trial and further selection. Selections of certain desired plant types and genetic constitutions were made in various progenies for further crosses and also for further trials in nursery rows. A promising strain, S. A. 1372, was found to be remarkably free from damage to a severe infestation of *Helminthosporium turcicum* which badly damaged other selections growing in the nursery. This strain is also a valuable forage type, homozygous for prolific side branching and tillering habits and a vigorous grower, producing large amounts of forage. It is being used for further crosses to combine non-shattering, sweet stem, and sienna glume with these other characters. Strains segregating for glossy and non-glossy plants gave good ratios for single factor segregation. Glossy is recessive. This character is apparent in the seedling stage and also in the mature plant, particularly in the new growth of tillers or side branches. The non-glossy plants are dull blue-green in color, especially on the under side of the leaf, while the glossy plants are smooth, bright, and lighter green in color. The Sudan grass parent is usually the non-glossy type but both types are found in mixed populations of Sudan.

In a preliminary grazing experiment where eight dairy cows were turned in on 150 progeny rows of Sudan grass breeding material, they showed a distinct preference for certain rows. Some 15 progeny rows were grazed down closely, others only slightly, and some, including the Sudan grass parent checks, were grazed practically none at all by the cows which had free choice. It appeared that juicy-stalked and sweet-stalked selections were preferred but some other qualities may also have been the object of their preference. Further similar trials with selected strains will be conducted.

Two new male steriles, ms_3 and ms_4 , were discovered, one of which has good, long stigmas desirable for use in natural crossing for production of crossed seed of sorghums. Further trials between numerous combinations of crosses to observe their hybrid vigor response, economic advantages, yield increases, and suitability for growing hybrid sorghums, were conducted in field plats. Some large increases in yields were obtained from combinations which were not accompanied by unusual tallness or lateness in maturity and appear promising for practical utilization when the problem of obtaining crossed seed in quantity is simplified.

Length of peduncle is an important economic character in sorghums having a bearing upon harvesting utility, position of the head and damage to grain in parts of the head depending upon exertion. Studies on the inheritance of peduncle characters have shown that short peduncle is a simple recessive to long peduncle. The leaf sheath is quite constant in length and independent of peduncle length so that segregates or varieties

having short peduncle may not be able to fully exert, and mold or fail to set seed well in portions of the panicle covered by the boot. Selection in such recessive lines would be futile. Thick peduncle also appears to be recessive to thin or slender peduncle.

Breeding work for the purpose of developing good popping types of sorghum has provided several F_2 generation progenies of crosses between hard, flinty, foreign varieties and adapted, early, native varieties. Further selections will be made on the basis of popping trials.

The inheritance and linkage relation of numerous characters in sorghum are being investigated. Certain desirable genetic characters are being transferred and incorporated into important commercial varieties which already possess other valuable characters. Breeding procedure involving crossing, backcrossing, and selection, is meeting with very satisfactory results and some of the objectives are nearing completion. Yellow-seeded varieties of Hegari, kafir, and feterita, sweet or juicy stem in such varieties as milo, absence of undercoat in otherwise white-seeded varieties, non-shattering seed habits, sorgos with palatable seed free from tannin, and resistance to sorghum leaf spotting diseases comprise some of the major problems under way.

R. E. Karper, J. R. Quinby, and D. L. Jones.

Effect of Fertilizers on Yield, Chemical Composition and Botanical Composition of Pasture Herbage

(In cooperation with the Tennessee Valley Authority)

This work was begun in 1936 in cooperation with the Tennessee Valley Authority to determine the effect of phosphates and other fertilizers on the yield, chemical composition, and botanical composition of pasture herbage. It is conducted at College Station, Angleton, Lufkin, Tyler, and Denton. The results obtained at College Station only are discussed here. The results secured at Angleton are given in the report of Substation No. 3; the results at Lufkin, in the report of Substation No. 11; the results at Tyler, in the report of Substation No. 2; and those obtained at Denton in the report of Substation No. 6.

At College Station in 1938 the treatment consisting of 40 pounds of nitrogen and 80 pounds of phosphoric acid per acre made the largest yield, 5513 pounds of air-dry forage per acre. During the three years, 1936-38, this treatment also made the highest average yield, 3809 pounds of forage per acre. This is an average increase of 770 pounds per acre, or about 25 per cent, over the yield of the untreated soil, for the three years.

The results indicate that phosphoric acid (in TVA triple superphosphate) increased the yield of forage chiefly by increasing the yield and

proportion of bur clover. Apparently the use of nitrogenous fertilizers alone had no significant effect on yield of forage.

E. B. Reynolds, G. S. Fraps, R. L. Hensel, J. H. Jones.

Improvement of Range and Pasture Plants

Work on this project was carried on and expanded during the year. An additional half acre of land was acquired which makes it possible to add 600 plats, making a total of 1800, all of which will be used in the buffalo grass studies. Seed of this grass was secured from Mandan, North Dakota; Holdrege, Nebraska; Manhattan and Hays, Kansas; Fort Collins, Colorado; Woodward, Oklahoma, and from Castro, Dickens, Hardeman, Denton, Dallas, Coryell, Brazos, Tom Green, Bexar and La Salle counties in Texas. These, in addition to the four already established in the nursery, make a total of 16, which might be termed strains as they all show different characteristics in the nursery. The Temple strain continues to be the most distinctive as it is taller, more robust, vigorous, and appears to stand drought and cold better as it remains green longer during dry weather and in winter. All of the plats were clipped in August and showed a wide variation in yield. The Temple strain outyields all the other strains, the maximum yield per acre from the best plant being 7525 pounds of dry matter. Since this represents only one clipping it is reasonable to assume that if an additional clipping had been made the yield would have been even higher. Chemical analyses made of plants from the four strains show the Encinal strain to be highest in percentage of calcium with .84, in phosphoric acid with .29, and in protein with 10.05. The Temple strain was lowest with .77 per cent of calcium, .24 per cent of phosphoric acid, and 8.96 per cent of protein. A study of the sexes showed that the Temple strain produces 44.5 per cent of male plants, 44.5 per cent of female plants, and 8 per cent monoecious. The Chillicothe showed 12.6 per cent male, 47.8 per cent female, 37.4 per cent monoecious, and 2.1 per cent which have never bloomed. The Encinal plants showed 11 per cent male, 44.5 per cent female, and 44.5 per cent monoecious, while the Spur plants showed 37.5 per cent male, 25 per cent female, and 37.5 per cent monoecious. The accepted belief has been that in dioecious plants the ratio between males and females is about even. These data, however, seem to indicate that this is not true since there is such a difference in the strains. In addition, we found five plants which were perfect flowered in that the staminate spikes produced both anthers and stigmas. This discovery may be of importance and open up an entirely new field of study. There were 271 crosses made, 88 of which were between strains.

Seed of 76 different grasses were planted in rows in the spring of 1938 and notes taken on them. At the present time *Andropogon ischaemum* shows great promise and larger plantings are planned. A large planting in rows was made of Italian rye grass from which 26 types were selected. These types show great variation ranging from low, prostrate, fine-leaved

to large coarse-leaved plants. Some of the types are rust resistant. There is a great difference in time of maturing seed, some being very early while others are very late. Seed from these selections were planted this fall.

Attempts were made to cross Rhodes grass with other varieties of Chloris but it is too early to determine whether or not they were successful.

R. L. Hensel.

Limiting Factors in Pasture Production

Work with pasture fertilizers was continued and seems to indicate that the use of phosphorus gives the best response since the increase in clovers is significant. The fertilizer treatments have not increased grass yields but this may be due to the long, hot, dry summers during which time growth practically came to a standstill. Cooperative experiments with the United States Department of Agriculture were started in the fall. These are designed to test the effect of certain fertilizer combinations applied directly on established sod, to the growth of white, Persian, low hop, least hop, cluster, and subterranean clovers. These were also applied directly on the sod without any further treatment. There was practically no rainfall for two months after the experiments were started but indications are that the seed have started to germinate. Similar experiments were started at Lufkin and Tyler.

Studies with the spread of the mesquite tree in West Texas were started at Ozona. Plats were established in pastures in which different systems of grazing are in use to note what effect the system will have on the spread. Not enough time has elapsed to make a comparison possible.

R. L. Hensel.

Management of Grazing Lands

Due to favorable climatic conditions there was an excellent growth of clovers on the pastures at Lufkin in late winter and continuing into early summer. Grass growth was so satisfactory that the eight-pasture rotation was temporarily discontinued and two pastures were mowed for hay. The yield was so large that it was possible to sell a large portion of the hay which was in excess of the winter requirements of the livestock. The stand of grasses is so heavy that lespedeza is being crowded out. Observations indicate that this may be checked by heavier stocking than has been done in the past.

Cooperative experiments with the University of Texas on lands close to Ozona were started in March. The principal object is to determine the best way to combat bitterweed (*Actinea odorata*), either through cultural methods or through different systems of management. The

area consists of 3200 acres of University land and is divided into 15 pastures, so arranged that rotation grazing as well as yearlong grazing can be done with sheep alone, cattle and sheep in combination, and cattle alone. Two of the pastures are for emergency reserve use. Black medic, rescue grass, Italian rye grass, California alfalfa, oats, and fenugreek were planted on bitterweed hazard areas to note whether they can compete successfully with it. Three large and one small enclosure were constructed and vegetative chartings using the point quadrat were made in all pastures at intervals of three months. Approximately 100 permanent quadrats were established. These show among other things that tabosa grass is most abundant, followed in order by buffalo grass and curly mesquite grass. Permanently staked acre plats were established to study the spread of mesquite trees under the different systems of management. Burning was done on permanently marked plats to note whether this practice would have any effect on the spread of tabosa grass as well as its palatability.

R. L. Hensel.

Wheat Breeding and Wheat Production in the Panhandle-Plains Region

(In cooperation with the Soil Conservation Service,
U. S. Department of Agriculture)

This project was established in the fall of 1938 in cooperation with the Research Division of the Soil Conservation Service. It will replace that part of the wheat work in the Panhandle-Plains region which, up to the present time, has been carried on from Substation No. 6 at Denton. The station, owned by the Soil Conservation Service, is located 14 miles west of Amarillo and one-half mile west of Bushland, on U. S. Highway 66, in Potter and Randall counties, and comprises an area of 1620 acres. It is situated about 3800 feet above sea level on soils which are predominately Pullman and Richfield silty clay loams. The average annual rainfall at Amarillo from 1892-1937 was 20.99 inches; approximately three-fourths of which falls from April to October, inclusive.

Approximately 100 acres has been designated for wheat work by the State. The primary objects of the breeding project are: to develop new varieties of wheat especially adapted to the Southern Great Plains, and which are superior with respect to resistance to bunt, shattering, and drought, combined with high productivity and quality. Plantings made in the fall of 1938 included both field plat variety tests and nursery tests.

Variety Tests: The field plat variety test on the station consisted of 16 varieties planted in 1/40-acre field plats. They were planted in eight replications, four on dry land and four on irrigated land. In addition to the tests on the station, a test of 14 varieties in single plats was planted in Hansford County, and a test of 10 varieties in Floyd County, in cooperation with farmers in those areas.

Nursery Tests: Ninety-seven varieties and strains of hard and soft winter wheats were grown in three rod-row plats in the advanced nursery, including 30 varieties of the U.S.D.A. uniform yield nursery. A preliminary nursery of 130 varieties and strains was planted in 2-row, 8-foot plats. Both of these nurseries were planted in quadruplicate on both dry land and on irrigated land. A uniform bunt nursery of 50 varieties was planted in single rows in duplicate, in cooperation with the Bureau of Plant Industry.

Approximately 2000 head selections were planted in single rows. These were selected from Turkey, Blackhull and Tenmarq, as well as several bulk hybrids grown previously at the Denton station. Several bulk hybrids were also sown for further selection.

In addition to the winter wheat work, 30 varieties of winter oats and 50 varieties of winter barley were planted in winter hardiness nurseries in cooperation with the Bureau of Plant Industry.

David A. Reid, P. C. Mangelsdorf.

Flax as a Winter Crop in South Texas

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture)

Experiments in the production of flax as a winter crop in South Texas have been highly successful for the third consecutive year. In nursery plantings at College Station, Angleton, Beeville, and Winter Haven, all varieties survived the winter of 1937-38 with good stands. The Rio variety on all of the stations has given the highest average seed yield of all varieties grown for the three-year period. Rio has given a three-year average acre yield of 10.6 bushels at College Station, 8.6 bushels at Angleton, and 17.3 bushels at Beeville. At Winter Haven, where a flax nursery was grown under irrigation in 1938 for the first time, Bolley's Golden was the highest yielding variety, with an acre yield of 27.0 bushels. These yields compare very favorably with the United States average yield of 6.1 bushels per acre for the ten-year period ending in 1936.

The experimental plantings of flax on the experiment stations of South Texas have created a great deal of interest in the crop among farmers, and as a result about 20,000 acres of the crop were seeded on farms in the Gulf Coast region in the fall of 1938.

E. S. McFadden, P. C. Mangelsdorf.

Breeding Wheat and Oats for Resistance to Rust

(In cooperation with the Bureau of Plant Industry,
U. S. Department of Agriculture)

Among 465 wheat varieties of foreign origin tested this year about 20 varieties of the common wheat species were found to have moderate to

high resistance to both stem and leaf rust. Several of these are also promising in other respects which will make them of value as parental material in breeding wheats for South Texas conditions.

Selections from a Hope X Mediterranean No. 63 cross which are highly resistant to leaf rust and have mature plant resistance to stem rust gave good results at College Station and Temple in 1938. The greater part of these selections, however, proved to be susceptible to stem rust in their early stages of growth at Angleton and Beeville. This shows the importance of early as well as late resistance to stem rust for the Gulf Coast area of the State where temperatures favorable for rust development may occur throughout the winter.

Crosses between Hope X Mediterranean No. 63 selections which have mature plant resistance to stem rust and several other wheats that are resistant in their early stages of growth have given numerous segregates that remained entirely rust free throughout all stages of their development under severe rust epidemic conditions at College Station in 1938. This method of attack appears to present a solution of the problem of over-wintering of stem rust on wheat in South Texas.

New crown rust resistant oats developed in the cooperative breeding work at College Station gave good results at College Station and Temple in spite of a heavy infection of stem rust that occurred on them late in the season at both stations. At the Beeville station, where stem rust developed earlier than at College Station and Temple, all of the oat varieties were severely injured by that disease. This shows the importance of having varieties for South Texas that are resistant to both crown rust and stem rust.

Several thousand hybrid oat selections that carry resistance to both rusts, combined with plump red kernels and winter type of growth, are now undergoing preliminary trials in 5-foot rows at College Station. The more promising of these selections should be available for single rod-row trials at Temple, Beeville, and Angleton by the fall of 1939 or 1940.

Barley breeding work under way at College Station has as its object the combining of resistance to stem and leaf rust and other diseases with smooth awns, malting quality, and general adaptation to environmental conditions. The breeding material in this project was successfully advanced another generation during the past year.

E. S. McFadden, P. C. Mangelsdorf.

Inheritance and Improvement in Corn

The new yellow-seeded varieties of corn developed by the Texas Experiment Station are becoming increasingly popular in Texas and other states. Yellow Tuxpan is now extensively grown in Louisiana. This

variety is being further improved by hybridization with Denco Yellow Dent to produce a type with red cobs, a larger and softer seed with a deeper yellow color than now prevails. Texas Golden Prolific, developed at the Nacogdoches station, has made excellent yields in tests in Texas and Florida. It will probably be grown extensively not only in East Texas but throughout the southeastern states. It is being further improved by crossing with Yellow Surcropper to incorporate some of the drought resistance of the latter. Yellow Surcropper is now grown almost throughout Texas and to some extent in Oklahoma. Its carotene content has been improved by selection and some progress is being made in improving productiveness by selection in self-fertilized lines followed by hybridization of lines which have been selfed one generation.

The work on sweet corn breeding is now largely concentrated on the production of selfed lines. Purdue 39, one of the best sweet corn strains in the United States, is being modified by crossing with Texas sweet corn varieties so that it will be adapted to Texas conditions. By using the greenhouse for a winter generation, rapid progress has been made in this work and some very promising lines are now approaching uniformity. By crossing these with lines developed from Texas sweet corn varieties it is hoped to develop hybrid sweet corn suitable for growing in Texas. The uniformity of hybrid corn is of great importance to the canning industry.

The development of hybrid field corn for Texas has now reached the stage where commercial production of hybrid corn is feasible. The four best inbreds available have produced increases in yield ranging from 35 to 41 per cent when used in top crosses with Yellow Surcropper. The seed supply of these strains is now being increased. A limited amount of seed should be available for distribution in 1940 and the first hybrid seed should be available to farmers in the spring of 1941. In the meantime extensive tests of Corn-Belt hybrids which are commercially available are being made to determine whether any of these are adapted to Texas conditions.

P. C. Mangelsdorf.

The Genetic and Cytological Relationship of Zea, Tripsacum, and Euchlaena

(In cooperation with School of Arts and Sciences, A. & M. College of Texas)

As a result of research conducted under this project the problem of the origin of corn appears to have been solved, at least so far as its principal features are concerned. As stated in the last annual report, corn probably originated from a wild form of pod corn growing in South America, while Euchlaena is the product of a natural hybrid of corn and Tripsacum. Pod corn, which is not now known in Peru, has been discovered there on the prehistoric pottery. Our conclusion that pod corn once grew in the Andean

region as a wild plant has had to be modified by geographical and historical studies which indicate that its wild habitat probably occurred in the South American lowlands. Correspondence with a botanical collector in Paraguay indicates that wild corn may still be in existence there. The fact that *Euchlaena* is intermediate between North American corn and *Tripsacum* in number and position of chromosome knobs suggested that the knobs on the chromosomes of *Euchlaena* and North American corn may have come originally from *Tripsacum*, in which case pure corn, uncontaminated with *Tripsacum*, might be expected to have knobless chromosomes. Cytological studies have shown that the corn varieties from the Andean region, especially Peru, have, for the most part, knobless chromosomes.

A preliminary paper presenting the new findings has been published in the Proceedings of the National Academy of Sciences. A comprehensive monograph reporting the research and reviewing the historical, archaeological, and botanical literature is now in press.

P. C. Mangelsdorf, R. G. Reeves.

Root Initiation of Cotton Plant Material by the Use of Hormones

Indolebutyric acid in aqueous solutions of 100 parts per million materially shortened the time required for mature cotton plants to overcome the shock of transplanting when the hormone solution was applied to the roots of the plants for 18 hours prior to resetting them. During the fall of 1938 a number of mature field grown cotton plants were transplanted into the greenhouse prior to frost. All plants moved were severely pruned, removing all foliage, and were closely placed in clean sand. No bottom heat was used and the range of greenhouse temperatures was from 65° F. to 85° F.

All cotton plants transplanted, both treated and untreated, developed foliage within two weeks after resetting. Over 90 per cent of the plants treated with 100 parts per million of indolebutyric acid developed an abundance of new roots and were well established by the end of the two-week period. During the same period approximately 50 per cent of the untreated plants developed new roots and in most cases the new root growth was limited to one or two roots per plant. However, most all the untreated plants developed new roots by the end of six weeks. The new root systems of the treated plants were not only more extensive but were initiated from 3 to 4 weeks earlier than those of the untreated plants.

Aqueous solutions of 50, 37, and 25 parts of indolebutyric acid were also effective in stimulating the initiation of new roots on mature cotton plants following transplanting. Concentrations of 12, 6, and 2 parts of indolebutyric acid appeared to be too dilute for dependable results. Sufficient data have not yet been accumulated to clearly indicate an optimum concentration. However, where the treatment is for as long as 18 hours, 37 parts per million appears to be almost as effective as 100 parts.

Solutions of all concentrations were used for three lots of plants on three successive days. Plants treated with the three-day old solution produced new roots almost as readily and almost as abundantly as those treated with fresh solutions. The gradual diminution in effectiveness of the solutions with age was primarily shown in reduction in total linear root growth per plant.

Prior to transplanting, the roots of mature cotton plants were treated with fresh aqueous solutions of 100 parts of indolebutyric acid per million for 12, 18, and 48 hours. Twelve-hour treatments were not effective while 18-hour treatments were as effective as 48-hour treatments.

Preliminary trials with naphthalene acetic acid indicate that cotton roots do not respond to treatment with this hormone.

Indolebutyric acid in aqueous solutions of 100 parts per million was effective in stimulating root initiation of mature and semi-mature stem cuttings of cotton. In a preliminary trial during the fall of 1938, mature stem cuttings were placed in tap water following a pretreatment to their bases with 100 parts of indolebutyric acid for 18 hours. Seventy per cent of these cuttings rooted profusely within 45 days. Clean sand was used as the rooting media in a more extensive trial in which the cuttings were kept for 60 days under the greenhouse conditions previously cited. One lot of mature cuttings treated with freshly prepared solution rooted 100 per cent and another lot, 94 per cent. Given identical treatment 95 per cent of the semi-mature cuttings rooted. Only 10 per cent of the untreated cuttings rooted. Delaying the treatment of cutting with this hormone for 24 hours after the cuttings were prepared apparently had very little effect on the percentage of cuttings rooted. Cuttings treated with two-day old solution rooted almost as well as those treated with fresh solution.

Although moderate success has been secured in previous years with untreated soft stem cuttings of cotton very few of the cuttings of this type tried this season were successful. Most of the soft wood cuttings in both the treated and untreated lots molded before they had time to root.

H. E. Rea.

Methods of Inoculation with *Phymatotrichum* Root Rot for Greenhouse Use

The development of methods of inoculating susceptible plants with *Phymatotrichum omnivorum* sufficiently reliable for use in greenhouse experiments has been undertaken jointly by the Division of Agronomy and the Division of Plant Pathology and Physiology. Seedling cotton plants, transplanted field matured cotton plants, and sweet potato cuttings have been inoculated. The preparation and placement of the inoculum, the soil used, and other environmental factors have been manipulated to study their effect on the growth of the fungus and the plants inoculated.

H. E. Rea.

Pasture Improvement and Management for East Texas

The work on this project is conducted at Substation No. 2, Tyler; Substation No. 3, Angleton; Substation No. 4, Beaumont; and at the East Texas Pasture Investigations, Lufkin. The results for the current year 1938, will be found in the reports from these stations.

E. B. Reynolds.

Factors Affecting Storage of Water in the Soil

(In cooperation with Soil Conservation Service,
U. S. Department of Agriculture)

This project is conducted at Substation No. 7, Spur, and a report of the work will be found under that station.

E. B. Reynolds, R. E. Dickson, B. C. Langley, C. E. Fisher.

Improvement of the Peanut

Some work was done on this project in 1938, the results of which are given in the report of the Main Station Agronomy Farm.

E. B. Reynolds.

Time and Method of Seed-Bed Preparation

This work is being done at Substation No. 8, Lubbock, to determine the best time and method of preparing the land for cotton and grain sorghum. The results of these studies will appear in the report of Substation No. 8.

E. B. Reynolds.

Time and Method of Intertillage

Work under this project is being conducted at Substation No. 12, Chillum, and the results will be given in the report of that station.

E. B. Reynolds.

Plant Introduction

New plants are introduced from time to time as opportunity permits but no outstanding introductions were observed in 1938.

E. B. Reynolds.

MAIN STATION AGRONOMY FARM

The Main Station Agronomy Farm is located on the land of the Agricultural and Mechanical College of Texas at College Station, Brazos County. The station comprises 101 acres of land, 76 acres of which are used for experimental purposes and the remaining acreage for buildings, pastures, and roadways, and for the production of seed of superior strains of crops on the farm for distribution to farmers.

Rotation and Soil Improvement Investigations

The object of this test is to determine the effects of rotation on the yield of crops and the behavior of crops under different fertilizer treatments. This test consists of a four-year rotation of corn, cotton, oats, and cowpeas in comparison with continuous corn and continuous cotton. Both rotated and non-rotated acres receive treatments of cotton seed meal, barnyard manure, superphosphate, and rock phosphate, with check plats of no treatment, and one plat having the crop residue removed.

Cotton: During the 25-year period (1914-38) the treatment of manure alone produced 235 pounds of lint per acre, the manure and rock phosphate produced 228 pounds, and the manure and superphosphate produced 236 pounds per acre in the rotated cotton, as compared to 237 pounds for the manure alone, 227 pounds for the manure and rock phosphate, and 213 pounds for the manure and superphosphate in the non-rotated cotton. The plat which had the crop residue removed produced 166 pounds of lint per acre in the rotated cotton as compared to 180 pounds in the non-rotated cotton.

Corn: For the same period of years, the treatment of 4 tons of manure produced 24.5 bushels per acre, and the treatment of 4 tons of manure and 200 pounds of superphosphate produced 23.8 bushels in the rotated corn as compared to 16.2 bushels for the manure alone, and 17.2 bushels for the manure and superphosphate in the non-rotated corn. The average yield of the plat from which the crop residue had been removed was 18.5 bushels for the rotated corn as compared to 12.0 bushels for the non-rotated corn.

Oats: The treatment of cotton seed meal and superphosphate produced 16.0 bushels of grain per acre over the period of years and the plat from which the crop residue had been removed produced 13.86 bushels of grain per acre.

Fertilizer Experiments

The object of this test is to determine the fertilizer needs of cotton, corn, and oats on the Lufkin fine sandy loam soil. This test consists of a three-year rotation of cotton, corn, and oats in which a 4-12-4 fertilizer at the rate of 400 pounds to the acre is used as a standard treatment. Then each element—nitrogen, phosphoric acid, and potash—is varied in turn, while the other two are kept constant. The 4-12-4 fertilizer is also used at rates of 200, 600, and 800 pounds to the acre.

Cotton: During the twelve-year period (1927-38) the treatment producing the highest average yield was 12 tons of manure and 400 pounds of superphosphate, 377 pounds of lint to the acre, or 70 pounds per acre more than the average of the check plat which received no treatment. The treatment producing the second highest yield was 12 tons of manure per acre, 355 pounds of lint per acre.

Corn: For the same period of years the treatment producing the highest yield of corn was 12 tons of manure and 400 pounds of super-phosphate, 30.8 bushels of corn per acre. The plat which received no treatment produced 21.3 bushels per acre, or 9.5 bushels per acre less than the fertilized plat.

Oats: During the period of years the treatment producing the highest yield of grain was 800 pounds of 4-12-4, 22.05 bushels per acre. The treatment of 600 pounds of 4-12-4 produced 21.98 bushels per acre and 490 pounds of 6-12-4 produced 20.68 bushels per acre. The untreated plat produced 16.72 bushels per acre or 5.33 bushels per acre less than the highest yielding plat.

Source of Nitrogen Test

The object of this test is to determine the best source of nitrogen for cotton. Each fertilizer treatment is a 4-8-4 but the source of nitrogen for the treatment is supplied by different materials. The sources of nitrogen consist of ammonium phosphate, white polyhalite, sodium nitrate, nitrated phosphate, cyanamid, ammonium sulphate, red polyhalite, uramon, and ammonium nitrate. There was one plat which received no treatment. The treatment producing the highest yield was ammonium nitrate, 337 pounds of lint to the acre.

Cotton Variety Test

This test consisted of 56 varieties in 1938 and of those varieties the three highest yielding varieties were: Ferguson 406, 467 pounds of lint per acre; Acala (N. M. College Strain), 383 pounds, and D. & P. L. 11A, 381 pounds. On the basis of comparable yields among those varieties that have been grown for 10 years or longer, the three highest yielding varieties are: New Boykin and Ferguson 406, both with 245 pounds of lint per acre, and Sunshine, with 226 pounds of lint per acre. However, Startex 619, a selection developed on the Main Station Farm, has been grown for the past eight years and has a comparable yield of 232 pounds of lint per acre.

Spacing and Fertilizer Test with Cotton

The object of this test is to determine the best spacing for cotton plants on poor, medium, and fertile soils. The poor soil was represented by soil having no fertilizer applied, the medium soil was represented by having an application of 400 pounds of 4-8-4 fertilizer to the acre, and the fertile soil was represented by having an application of 800 pounds of 4-8-4 fertilizer to the acre. The spacings used were 12, 18, and 24 inches, each being used on all three types of soil. During the three years (1936-38) this test has been conducted, the 12-inch spacing gave the highest yields on all three types of soil, 202 pounds of lint per acre on the poor soil,

265 pounds on the medium soil, and 303 pounds on the fertile soil. The 18-inch spacings made higher yields on all three types of soils than the 24-inch spacings.

Green Manure Test

This test consisted of 30 plats, half of which were planted with hairy vetch and the other half left winter fallow. In the spring the vetch was plowed under and all plats received an application of commercial fertilizer, all nitrogen being withheld from those plats having vetch. The object of this test is to determine the amount of nitrogen made available by the vetch.

For the 2-year period (1937 and 1938) during which this test has been conducted, the yield of the plats having vetch and an application of 500 lbs. of 0-8-4 fertilizer was 331 lbs. of lint per acre, as compared to 334 lbs. of lint for those plats having no vetch and an application of 500 lbs. of 4-8-4 fertilizer. This indicates that, for all practical purposes, vetch adds as much nitrogen to the soil as cotton can use.

Variety Spinning Test

This test, being conducted in cooperation with the United States Department of Agriculture, consists of two varieties, replicated twice. The object of the test is to determine which variety is better from the standpoint of spinning qualities. The results of this test are gathered by the U. S. D. A. at Stoneville, Mississippi, and have not been made public.

Regional Variety Wilt Studies

This test is conducted at the Station jointly by the Main Station Farm, the Division of Plant Pathology, and the United States Department of Agriculture. A report of the results of this test may be found under the Division of Plant Pathology.

Peanut Breeding

The Macspan and Virginia Bunch has been crossed and increased plantings of the cross made. The object is to get a peanut with the fine eating qualities of the Macspan and the non-sprouting quality of the Virginia Bunch when left in the field after maturity. A few seed of the cross have been obtained and will be increased as rapidly as possible.

Increase of Pure Seed

Increased plantings of Startex 619 cotton, Macspan peanuts, Yellow Surcrotter corn, Surcrotter Sugar sweet corn, and Red Shuck sweet corn were made in order to have seed available for distribution to seedsmen and farmers throughout the State and other states.

J. E. Roberts.

PLANT PATHOLOGY AND PHYSIOLOGY

Cotton Root Rot Investigations

(Including investigations in cooperation with Bureau of Plant Industry,
U. S. Department of Agriculture)

Cotton root rot in Texas in 1938

The effect of root rot, *Phymatotrichum omnivorum* (Shear) Duggar, on the 1938 cotton crop was estimated on the basis of 1,590 separate field estimates in 28 counties. The main and southern Blackland Prairies sections were covered rather thoroughly in these surveys. Rainfall during the growing season favored continued spread of root rot in several areas, and in some localities there was almost complete kill of plants by September. On the average the weather over the State was definitely more favorable for root rot than in 1937. The mean reduction in yield due to the disease was probably slightly below normal and is estimated roughly at about 7.6% of the expected yield—a loss of around 257,000 bales.

W. N. Ezekiel.

Conditions affecting local prevalence of root rot on cotton

A study of the particular weather conditions that govern the local prevalence of root rot was begun in 1937. Results obtained in study of the 1937 data have been published in Plant Disease Reporter 22: 315-324, 1938. Additional results provided by the 1938 surveys agree with those of last year in indicating that destructiveness of root rot on cotton, in the favorable Blackland Prairie soil areas, is limited largely by the rainfall in any particular season, and that the effect of a given increase in rainfall is progressively greater as the season advances. Increase in rainfall beyond a certain maximum figure for each month, however, does not cause a corresponding increase in root rot. The greatest loss from the disease is found in localities with favorable rainfall continuing throughout the season.

W. N. Ezekiel.

Studies on the life history of *Phymatotrichum omnivorum*

In continued study of the *Phymatotrichum* spore stage, attempts to encourage development of this stage in artificial cultures, to germinate the spores, and to inoculate cotton plants with the spores, were still unsuccessful. Lack of germination was apparently not from: undue shortness of the period of testing (some spores were kept under observation for 26 months); lack of oxygen; competition with contaminant bacteria or fungi; excess humidity in a Van Tieghem cell set-up, nor need of activation of spores by pre-heating, pre-chilling, or incubation at refrigerator temperatures.

In connection with studies on variation within the root-rot fungus, an interesting anomaly appeared in the rate of growth at room temperature

of transfers from individual parent colonies selected respectively as more slowly or more rapidly growing than the average of otherwise uniform groups. Almost without exception, the transfers from slowly growing parent colonies have grown more rapidly than have accompanying transfers from rapidly growing parent cultures.

It was noted (1937) that transfers made with small hyphal or sclerotial portions from the parent cultures yielded greatly reduced growth as compared to transfers made with larger portions. In several experiments this year, addition of small amounts of an auxin, beta (indole-3) propionic acid, to various nutrient media did not prevent this reduction in rate, vigor, and extent of growth from inocula cut to 1/18 the usual size. The lesser growth from smaller inocula was presumably not due to lack of this particular growth-promoting material.

In several phases of work with root rot, a reliable method of inoculation for use under greenhouse conditions would be of considerable value. In cooperation with the Division of Agronomy, experiments have been carried on toward development of such a technique.

W. N. Ezekiel.

Studies on the cause of immunity of monocotyledonous plants to *Phymatotrichum* root rot

A summary of studies carried on to find why the monocotyledonous plants, including all grass and grain crops, are immune to root rot, has been published (Jour. Agr. Res. 56: 773-786, 1938). It was found that this general immunity is due at least in part to the presence in roots of these plants of minute quantities of acidic, ether-soluble substances capable of preventing growth of the root-rot fungus. Recent qualitative tests indicate that the potent fractions prepared by our technique from canna roots, onion bulbs, or *Hemerocallis* roots contain little or no nitrogen, which would apparently preclude the presence of nitrogenous bases, such as alkaloids, in these fractions. In fractions from canna roots, the constituent most potent in preventing growth of *P. omnivorum* is apparently colorless in the solvents used, of high combining weight, precipitated by lead acetate, insoluble in water but soluble in aqueous sodium-carbonate solution, readily soluble in chloroform, alcohols, acetone, ethyl ether, and somewhat less soluble in benzene and petroleum ether. This potent constituent when present in nutrient solutions at concentrations as low as .01 per cent, completely prevents growth of the root-rot fungus.

W. N. Ezekiel, P. F. Macy.

Girdling of cotton plants as affecting survival of *Phymatotrichum omnivorum*

A possible new point of attack against the root-rot fungus on cotton and other host plants was tested in preliminary experiments which involved girdling of cotton stems, just above the ground, in plats that included some plants with root rot and others to which the disease ordi-

narily would spread. Several plats of cotton plants were girdled on July 29, 1938. Within 11 days, the girdled plants showed bronzing of the foliage and within a month a third of the plants were dead. Portions of the roots (analyzed by the Division of Chemistry) showed rapid decrease in alcohol-soluble solids and total sugars. Tests in the laboratory of the viability of the fungus, in roots of plants excavated after 3, 5, and 8 weeks, showed no trace of viable *P. omnivorum* on the roots from girdled plants, either those that had root rot at the beginning of the experiment or those adjoining plants to which root rot ordinarily would have spread. On the other hand, the fungus was still alive and grew readily from roots of the untreated plants.

A second series of plats was set up September 3, 1938. Girdling of cotton plants at this time produced no apparent change in the above-ground appearance of the plants even after a month; nor did treatment at this time affect the fungus on the roots, since roots from girdled plants and from plants with the tops cut off entirely were found to yield as high percentages of viable *P. omnivorum* as did roots from the untreated check plants. Girdling the stems during the period of rapid growth in summer apparently made the roots no longer suitable for continued survival or spread of the root-rot fungus, while similar treatment in fall did not cause such change. These preliminary results will require further testing.

W. N. Ezekiel.

Field studies on resistance to cotton root rot

Field studies with the root-rot disease of cotton have been concerned with the possibility of resistance to this disease among the cultivated and wild species of *Gossypium* and related genera, and in interspecific hybrids of cultivated and wild cottons. The results of these trials on root-rot infested soils in the Blacklands area of central Texas in 1938 gave little promise of resistance to the fungus. All of the progenies were found to be susceptible to infection, although certain of the progenies were less susceptible than others, based upon the time of appearance and severity of symptoms of the disease. The material will be tested again in 1939.

L. M. Blank (Bu. Pl. Ind.).

Nutrition of *Phymatotrichum omnivorum* and the effects of certain metallic ions on growth of the fungus

The nutritional requirements of *P. omnivorum* and the response of the organism to various elements have been studied under carefully controlled conditions in laboratory experiments. The root-rot fungus is tolerant of a wide variation in concentration of the nutrient salts used in synthetic nutrient solutions. Some seventeen carbohydrates have been tested as carbon sources for the organism in a nutrient solution, along with a study of the carbohydrate splitting enzymes produced by the organism. The relationship between the utilization of various carbohydrates and the ability of the fungus to digest these specific carbohydrates is very close.

The effect of the addition of copper, iron, manganese, zinc, aluminum, boron, cadmium, cobalt, fluorine, iodine, mercury, lithium, molybdenum, nickel, or silicon to a nutrient solution and resultant growth of the organism has been studied. The addition of certain of these elements (zinc, iron, or manganese) in small amounts has resulted in considerable increases in growth of the fungus, whereas others are toxic even when used in low concentrations. The more toxic include copper, cobalt, and nickel.

L. M. Blank (Bu. Pl. Ind.).

Chemical studies on the nature of resistance of certain plants to *Phymatotrichum* root rot

The major problem has been to isolate chemical compounds from plants resistant or immune to *P. omnivorum* and to study the influence of these compounds on the growth of the root-rot fungus under controlled conditions.

Preliminary studies indicated that plant alkaloids might be one of the factors in the resistance of plants to *Phymatotrichum* root rot. Berberine has been isolated from *Mahonia trifoliolata* and *M. Swaseyi*, and sanguinarine, chelerythrine and protopine from *Sanguinaria canadensis*. These alkaloids were found to be present in the root tissue in far greater concentration than that shown experimentally to prevent completely the growth of *P. omnivorum*.

The toxicity of 52 other alkaloids to the root-rot fungus has been determined. These data furnish information on 50 to 70 species of plants from 15 families, which differ in their susceptibility to *Phymatotrichum*. The experimental data from these studies strongly suggest that alkaloids may play an important role in the mechanism of resistance of some plants to this fungus.

A procedure has been devised for extracting dried tissue with a series of solvents and testing the potency of each extract against *P. omnivorum*. Twelve root materials from both resistant and susceptible plants are being tested by this technique in order to classify as to chemical type any inhibitory compounds found. Preliminary experiments indicate that essential oils are partly responsible for the resistance of citrus, along with substances of an alkaloidal nature, such as those isolated in crystalline form from *C. aurantium* root bark.

G. A. Greathouse (Bu. Pl. Ind.) and N. E. Rigler.

Distribution of berberine in roots of *Mahonia trifoliolata* and *M. Swaseyi*

A microchemical study of sections of roots of *Mahonia trifoliolata* and *M. Swaseyi* showed that the alkaloid, berberine, is impregnated in the walls of tracheids, vessels, and bast fibers, and is present in lumina of cells in the xylem and phloem rays and in the older phloem cells. A

more or less continuous sheath of berberine-containing cells surrounds the root just beneath the periderm. Berberine is thus so located as to be effective in warding off the attack of the root-rot fungus.

G. A. Greathouse (Bu. Pl. Ind.) and G. M. Watkins.

Cotton root-rot and other studies at Temple

Soil treatments with oil and cotton bur ashes; analyses of seed from different cotton varieties; analyses of seed from plants killed by root rot; resistance of cowpea varieties to root rot; cotton seed treatments; and occurrence of *Phymatotrichum sclerotia* in the soil are reported under Substation No. 5, Temple.

C. H. Rogers.

Cotton root-rot studies at Iowa Park

Results of experiments involving crude oil treatments of the soil, cropping with sorghum, and resistance of grape root stocks are included under Substation No. 16, Iowa Park.

L. E. Brooks.

Other Cotton Diseases

Cotton Seed Treatment Test

In cooperation with the Cotton Seedling Disease Committee of the American Phytopathological Society, a test was made of the effect of Ceresan seed treatments on seed of several varieties of cotton, some known to be infected with *Bacterium malvacearum*, *Fusarium moniliforme*, or *Glomerella gossypii*. Seed treatments gave the greatest benefits on seeds which were infected with the above organisms. However, treated seeds gave increased stands over untreated seeds in all cases. Differences in yields in this test were relatively small, and statistically insignificant.

Another test using different kinds of seed treatments on one variety was also completed. The following proprietary compounds were used on acid-delinted, mechanically-delinted and non-delinted cotton seed: Barbak C, New Improved Ceresan, and Ceresan. This particular sample of acid-delinted seed possibly was injured in some way because it failed to emerge as well as either the non-delinted or mechanically-delinted seed. This difference in emergence was pronounced in cases where no additional treatments were made. The difference was practically eliminated by the seed treatments, however, so that the final variations in stand were slight following thinning to a definite number of plants. The greatest increases in stand due to the chemical treatments were obtained on acid-delinted seeds. Mechanically-delinted seeds showed the next greatest benefit from treatment.

G. E. Altstatt, A. L. Burkett.

Regional Cotton Wilt Variety Studies

In cooperation with the Division of Cotton and Other Fiber Crops and Diseases, Bureau of Plant Industry, a test was conducted to determine the relative resistance of different varieties of cotton to cotton wilt,

Fusarium vasinfectum. The effect of the application of different kinds of potash fertilizers was also studied in this test. The incidence of wilt in plats at College Station was low. Consequently, a thorough test of the wilt resistance was impossible and little could be ascertained of the effect of the potash fertilizers on the disease.

A record was made of the date of flowering to determine the earliness of each variety and the date of maturity of the bolls. Dixie Triumph 12, Toole (Perry), and Rowden 2088 were the earliest and heaviest producers of flowers. All varieties produced tenderable length of staple, ranging from 13/16-inch for Half and Half to 1 3/32-inch for Coker 100. The heaviest yield from the 6-8-0 fertilizer series was made by Half and Half with 584 pounds of lint per acre, followed by D. & P. L. 11A yielding 547 pounds, and Cook's 144-68 with 499 pounds per acre. In the 6-8-4 series, D. & P. L. 11A was highest with a yield of 561 pounds followed by Half and Half with 540 pounds, and Dixie Triumph 12 with 526 pounds per acre. In the 6-8-8 series, Half and Half again led with a total yield of 625 pounds per acre, and Miller 610 and D. & P. L. 11A with 571 and 515 pounds, respectively.

G. E. Altstatt, A. L. Burkett, D. T. Killough, J. E. Roberts.

For results of a similar test at Jacksonville, see report of Substation No. 11, Nacogdoches.

P. A. Young.

Tomato Diseases

Control of bacterial spot and early blight of tomatoes

Spraying experiments were conducted at the Tomato Disease Laboratory, Yoakum, upon tomato plants growing in the field, using homemade 4-4-50 Bordeaux mixture, commercial Bordeaux mixture, Cuprocide "54" and Copper Hydro "40". Each of these materials gave satisfactory control of bacterial spot, *Bacterium vesicatorium*, which occurred to a slight extent in the experimental plats. Early blight, *Alternaria solani*, was found to be controlled by the homemade Bordeaux mixture even after the disease had become established in the field. The highest yields of marketable fruits were obtained from the plats sprayed with Cuprocide "54", although this material was less effective against early blight than the homemade Bordeaux. Commercial Bordeaux mixture was about equal in fungicidal value to Cuprocide "54". Copper Hydro "40" was found somewhat less effective than the other materials used as an early blight control. The addition of cotton seed oil to homemade Bordeaux did not result in any increase in yield, although there was less leaf injury when the oil was used.

A. L. Harrison.

Experiments in damping-off control with tomatoes

The best results were obtained by dusting the tomato seed with red copper oxide (Cuprocide), when ordinary field soil and wooden flats were

used. Soil treatments with a proprietary dust compound (DuBay 1155 HH) gave fair control of damping-off when applied at a rate of 200 pounds per acre. Applications of this compound at rates of 50 pounds and 100 pounds per acre were not effective.

A. L. Harrison.

The use of roll poles for plant-bed covers to prevent tomato diseases

Ventilation and sunlight indirectly affect the incidence of disease among plants under seed-bed or cold-frame conditions. Previously, the sheets covering these beds have been fastened by the laborious and costly method of hooking the edges on to nails in the frame. As a result of this inconvenient practice, growers have been inclined to keep the frames covered too much, which causes etiolation of the plants, increases the humidity and in general tends to encourage the spread of plant pathogens. During the past year at the Yoakum Tomato Disease Laboratory, a roll pole has been devised which greatly facilitates the manipulation of the sheet covering. Its use should prevent much of the loss from plant diseases under seed-bed or cold-frame conditions.

A. L. Harrison.

Seed transmission of tomato wilt and bacterial spot

Summary included in the report of Substation No. 11, Nacogdoches.

G. E. Altstatt.

Tomato Disease Investigations at Jacksonville

Studies on the resistance of tomato varieties to Fusarium wilt, on root-knot nematode control, foliage diseases, and damping-off of tomato seedlings are summarized in the report of Substation No. 11, Nacogdoches.

P. A. Young.

Rose Diseases

Effect of various fungicides on the black spot of rose

Field tests of 19 different combinations of fungicides were conducted during the spring and summer of 1938 on Luxembourg roses at College Station. The materials used were several copper compounds combined in various ways with a number of different forms of sulphur. The number of infected leaves and the amount of defoliation were used as criteria for determining the relative effectiveness of the different fungicides controlling black spot. The data from this single season's work suggest Cuprocide, Copper Hydro "40," and 3-3-50 Bordeaux mixture, as outstanding among the copper materials used in sprays. The addition of wettable sulphur to these fungicides seemed to reduce their efficiency in controlling black spot. Cuprocide and Copper Hydro "40" were superior in the dusts used.

G. M. Watkins.

Histological and culture work on Gloeosporium black canker of rose

Sections were cut of canes of Luxembourg rose which showed the characteristic black cankers associated with a species of Gloeosporium.

The same species of *Gloeosporium* has been isolated repeatedly in pure culture from typically diseased canes, but numerous attempts to infect 8 varieties of rose from pure cultures of the fungus have given negative results. Cytological studies have been made of the manner of infection, tissue invasion, and spore production in mature lesions.

G. M. Watkins.

Diseases of Cereal Crops

The effect of sulphur dusts on the occurrence of leaf rust of wheat

Wettable sulphur and 325-mesh dusting sulphur were applied three times to wheat on three widely separated farms in Baylor County during April and May. The results this season show no appreciable differences between treated and untreated wheat. The frequent rains in Baylor County during the spring made it impossible to keep the dusts on the wheat between applications, and it is doubtful that a test of the effect of sulphur on the occurrence of leaf rust was actually obtained.

G. M. Watkins.

Lodging of sorghum

Lodging of sorghum plants was noted in certain regions of Northwest Texas in 1938. The weather had been unusually wet early in the season followed by an extended dry period. The lodging occurred in somewhat circular spots in the field and the affected areas increased in size towards the end of the season. Typically, the stalk collapsed a few inches above the ground. Laboratory cultures from this portion of lodged stems showed *Sclerotium bataticola* Taub. to be present in the majority of cases. *Fusarium moniliforme* Sheld. was isolated frequently from lodged stalks that did not harbor *S. bataticola*. A similar condition has been reported (W. W. Mackie, *Phytopathology* 22: 637-644. 1932) as occurring on maize in California.

A. A. Dunlap.

Black kernel of rice

Various treatments designed to prevent black kernel are summarized in the report of Substation No. 4, Beaumont.

A. L. Martin.

Diseases of Garlic and Other Vegetable Crops

Selection and treatment of garlic bulbs

At Moulton favorable weather at harvest, seed-piece selection for planting, and the delaying of harvest until the plants were matured greatly improved the quality of the 1937-1938 crop. Selection of the bulbs for seed resulted in better stands and more uniform quality of garlic. Cloves from badly split bulbs produced a higher percentage of "splits" than cloves from ordinary field-run bulbs or selected No. 1 bulbs. No single seed treatment controlled all of the bulb diseases effectively, although the protection afforded the seedling plant reduced the mortality at this

stage. Weevil and white grub damage was generally slight, although a few cases of severe damage to young plants by the weevil were noted.

(Harvesting and curing trials with garlic are reported under the Division of Agricultural Engineering)

G. E. Altstatt, H. P. Smith.

Chemical treatments of seed and soil for control of damping-off

Various seed treatments, consisting of application of fungicidal dusts to the dry seed before planting, were tested upon a number of different kinds of vegetable seeds in field plats of Lufkin fine sandy loam soil. Among the materials used were Barbak C, Ceresan, Copper KB, Cuprocide, Semesan, wettable sulphur, and zinc oxide ("AAZ"). Seeds of beet, bush bean, broccoli, cabbage, carrot, cauliflower, lettuce, and parsnip were treated. Although all of the treatments, with the exception of wettable sulphur and Barbak C, generally resulted in increased stands of plants, Cuprocide was superior in this respect in the largest number of cases. Copper KB, Ceresan, and zinc oxide were also effective in controlling both pre-emergence and post-emergence damping-off, with certain kinds of seeds. Seedling injury was noted upon broccoli and cabbage with Ceresan. A soil drench (1¼ lb. Cuprocide "54" to 50 gal. water) applied to a four-inch strip along the row directly after planting and wetting the soil to a depth of from one to one and one-half inches, increased the stand of bush beans in a fall planting (September 25) to 48 per cent of the seeds planted as compared with 31 per cent for the untreated rows.

A. L. Burkett.

Further laboratory tests of fungicides upon spore germination

Various spray materials, such as sulphur, various insoluble copper compounds, zinc oxide, Paris green, calcium and lead arsenates, and fuller's earth were tested, both separately and in certain combinations, as to their effects upon germination of spores of *Curvularia lunata*, *Sphacelotheca sorghi*, *Fusarium* sp., *Diplodia* sp., *Gibberella saubinetii*, and *Basisporium gallarum*. The materials were added to suspensions of the spores in either water or nutrient solution on glass slides. The different kinds of spores were similarly inhibited in their germination by the materials used. In general, the copper compounds, zinc oxide, calcium and lead arsenates, and Paris green were effective in inhibiting germination. In some cases, combinations of sulphur and copper were more toxic than the copper compound alone. Different kinds of sulphur reduced the percentage of germination in varying degrees but sulphur alone rarely completely inhibited germination. Aging for one year did not materially affect the toxicity of various mixtures of the sulphurs, copper compounds, and arsenates.

Research on plant diseases in the Lower Rio Grande Valley

The results of experiments involving gummosis, wood rot, stem end rot, and chlorosis of citrus; early and late blights of potatoes, black rot

of cabbage, bacterial soft rot of tomatoes, stalk rot of corn, and soil sterilization with chloropicrin are given in the report of Substation No. 15, Weslaco.

G. H. Godfrey.

Vegetable disease work at Winter Haven

Experiments upon the white rust (Albugo), downy mildew and curly top of spinach; pink root and an undetermined "blight" of onions; and tomato "pox" are described in the report of Substation No. 19, Winter Haven.

S. S. Ivanoff.

SOIL SURVEY

(In cooperation with the Bureau of Chemistry and Soils,
U. S. Department of Agriculture)

During 1938 soil survey work was carried on in three counties, and the field work was done by parties made up of about an equal number of State and Federal men. The counties worked in were Fannin, Dimmit, and Brown, and a total of 741,760 acres was surveyed in detail in the three counties.

Soil mapping, in conformity to the national system, continues to be done more and more in detail and in such form as to meet the more specialized requirements of land use planning and other agencies concerned with aiding various branches of agriculture.

The chief of the division, also inspector for the Federal agencies co-operating in the surveys, made inspections of the field work from time to time to enable uniform classification and correlation of the soil units shown on the map and to help adjust these in line with the national system of scientific soil nomenclature and correlation. The results of the correlation, classification, and mapping of Texas soils are indicated in the latest soil map of the United States with generalized soil descriptions given in the 1938 Yearbook of the U. S. Department of Agriculture entitled "Soils and Men."

Soil Survey of Fannin County

The soil survey of Fannin County was finished early in the year. This survey was made on the scale of two inches to the mile, and slope and erosion features were indicated on the map, under the system of phase designations, in areas where slope and erosion varied essentially from the normal for the soil unit set up as the standard type.

This is an important county in the Blackland Prairie of northeastern Texas, and the information in the report and on the map will aid specialists and agricultural interests in adjusting their land use problems in the region. Advance copies of the soil survey field sheets were furnished to

representatives of the Farm Security Administration to aid in developing plans for the readjustment of certain land use problems. The report and field sheets have been sent to the office of the Soil Survey Division in Washington for preparation for publication.

E. H. Templin, J. W. Huckabee, Jr., I. C. Mowery,
M. H. Layton, W. T. Carter.

Soil Survey of Dimmit County

The soil survey of Dimmit County continued throughout the year, and field work was completed about the close of the year. The field sheets and report are about ready for transmittal to the Soil Survey Division in Washington where the data will be prepared for publication.

Dimmit County lies in southwestern Texas in what may be termed the semiarid region, and systematic dry farming is generally not practicable. It is in the Winter Garden District where winter vegetables, citrus fruits, and other special crops are grown under irrigation from streams and wells. The survey indicates the location of each of the soil type areas with boundaries delineating their approximate extent. Much of the county remains in large cattle ranches, and large areas of soils appear to be best suited for the ranching industry. Certain soils are highly desirable for special crops, many of which are already grown in large amounts and shipped to outside markets. The soil map and report will enable the selection of appropriate soils to be used for the particular types of agriculture and crops desired, and the data will also aid in the use of information developed in research at the Winter Haven sub-experiment station in the northern part of the county.

H. M. Smith, J. W. Huckabee, Jr., W. T. Carter.

Soil Survey of Brown County

The soil survey of Brown County was continued with the field party transferred from the Fannin County area.

The survey of this county has required unusual attention to details and to close study of soil characteristics to effect a satisfactory classification. The complexity of soil areas and their difficulty of delineation here is due to the fact that two great soil regions merge in the county in conjunction with a rather irregular system of geological outcrops which supply the soil parent materials.

A large irrigation project is being developed here, and the information furnished by the soil survey will enable the appropriate adjustment of agricultural operations to the various types of soil and land shown on the soil map and described in the report. It is expected that this area will be completed early in 1939.

E. H. Templin, I. C. Mowery, W. I. Watkins,
T. W. Glassey, W. T. Carter.

Miscellaneous

The Soil Survey Division cooperated with other divisions of the Station in collecting and providing information relating to soils in various sections of the State.

This included a detailed soil survey of the new Range Station near Ozona where the large-scale soil map constructed showed all of the several types and phases of soils on the Station land and indicated these are representative of large areas of the Edwards Plateau region.

The Lufkin Pasture Station near Lufkin was also covered by a detailed soil survey for the use of studies in pasture research in the East Texas Timber Country.

A general soil map of Hill County was made for the use of specialists of the Experiment Station and Extension Service in planning with the agricultural planning board of that county for future land use programs in the county.

In addition to inspections of soil surveys made by the cooperating soil survey divisions of the Experiment Station and the U. S. Department of Agriculture, the chief of the division inspected and wrote reports and correlation memorandums for a number of Soil Conservation Service surveys made in several parts of the State.

A series of radio talks on the soils of Texas was broadcasted from the radio station of the Agricultural and Mechanical College during the summer.

W. T. Carter, E. H. Templin, I. C. Mowery.

The soil survey reports of Bee and Williamson Counties were published and issued by the U. S. Government Printing Office during the year. Several other reports of county surveys are in process of publication and will be issued soon.

FARM AND RANCH ECONOMICS

Organization and Management of Farms in the High Plains Cotton Area of Texas

(In cooperation with the Bureau of Agricultural Economics, U. S. D. A.)

A detailed study of organization and management has been made on farms in the High Plains Cotton Area during the five-year period 1931-1935. The number of farms studied each year ranged from 127 to 141, and averaged 137. The main object of the study is to provide basic information for the use of farmers and farm leaders in formulating programs pertaining to agriculture. The results of this study have been summarized in three publications, which are in various stages of completion.

One of these publications, Bulletin 568, "An Economic Study of Farm Organization and Operation in the High Plains Cotton Area of Texas," already off the press, while describing the agriculture and agricultural resources of the area, deals primarily with the variations in farm earnings during the period of the study, and with the causes of these variations.

Average operator's earnings per farm amounted to \$223 in 1931, \$124 in 1932, \$1,808 in 1933, \$254 in 1934, and \$980 in 1935. These year to year variations in average earnings were caused by differences in yields and crop land organization, in farm prices paid and received, and in payments received for participation in Agricultural Adjustment Administration programs in 1933, 1934, and 1935.

The range of earnings on individual farms during each year of the study was wider than was the range in average earnings as between different years. An analysis of these differences in earnings on individual farms during 1931 and 1932 brought out that six factors accounted for 63 per cent of the variation during those years. These factors listed in order of their importance were (1) yield of cotton per acre; (2) percentage of farm land in cotton; (3) returns per \$100 of feed fed to produce livestock; (4) productive man work days per man, excluding harvesting labor; (5) size of farm; and (6) number of produce animal units per 100 acres of farm land.

When the farms were grouped according to the number of these factors in which they were above the average, it was found that earnings were progressively larger on farms with an increasingly larger number of factors above average accomplishment. Earnings ranged from a loss of \$487 on farms which were below average in all factors to a gain of \$1,099 on farms which were above average in all six factors.

The two other publications will be ready for publication some time during the coming year.

C. A. Bonnen and A. C. Magee; and B. H. Thibodeaux,
Bureau of Agricultural Economics.

Regional Agricultural Adjustment

(In cooperation with the Bureau of Agricultural Economics, U. S. D. A.)

This project has for its purpose the development of information, by type-of-farming areas, to facilitate the planning of agricultural adjustments in the agriculture of each area. The work has been divided into two phases:

1. The descriptive phase, in which the State is divided into areas within which there is a high degree of similarity in soils and other physical features, as well as in the character of the agriculture and its related physical and economic problems. Bulletin No. 544, "A Description of the Agriculture and Type-of-Farming Areas in Texas," has been published. Thirty-seven major areas and sub-areas are identified, and descriptive

material relating to the natural and economic factors contributing to the agriculture of each area is presented in this publication.

As a further refinement of the descriptive phase, the leaders of this project are assisting the Extension Service in the work of county agricultural program planning. In this work, each county is divided into areas by the county planning committees in somewhat the same manner as the State was divided into major type-of-farming areas. Each of these areas is then described as to its soils, topography, native vegetation, and present land-use. Both physical and economic problems of each area are considered and recommendations as to land-use are made. It is felt that the county planning work will provide an excellent basis for orienting research and extension programs, and will permit a more intelligent administration of all programs aimed at the adjustment of agriculture. During the past year, mimeographed reports were prepared for 32 counties in which work of this type was done.

2. The analytical phase, in which existing types of farming are explained in terms of the underlying causes, and in which detailed information pertaining to the production and production requirements of all of the alternative uses of land is being developed. Such information will permit a careful appraisal of the alternative uses of land and of any changes in land use which may be suggested from time to time in both action and educational programs.

Work is being done under this phase of the project in three areas, the Black Prairie Area, the Rolling Plains, and the High Plains Wheat Area. The field work has been completed and the data summarized in the first two areas named.

C. A. Bonnen and A. C. Magee; and B. H. Thibodeaux,
Bureau of Agricultural Economics.

Quality as a Factor in the Marketing of Vegetables in the Lower Rio Grande Valley of Texas

The purpose of this project is to determine the extent to which quality of vegetables affects the prices paid growers. The vegetables considered are: beets, cabbage, carrots, potatoes, and tomatoes. The data collected indicate a slight, if any, recognition of quality in the case of beets, cabbage, and carrots. As for potatoes and tomatoes, however, premiums are regularly and consistently paid on U. S. No. 1 as contrasted with U. S. No. 2.

A manuscript is in preparation closing out the project.

W. E. Paulson.

Central and Local Market Prices of Wheat in Relation to Quality

(In cooperation with the School of Agriculture, A. & M. College
of Texas, and the Division of Chemistry)

The object of this project is that of determining the relation of protein test and grade of wheat to the prices received by growers in the Pan-

handle area of Texas. The data collected indicate that grade, principally as reflected in test weight per bushel, is definitely recognized in prices paid to growers in the local market. As between growers delivering their wheat to a given local market, no ascertainable recognition is given to protein content. To the extent that light test weight is correlated to high protein content, the grower who has light weight wheat is penalized on grade while he may be enhancing the value of the wheat in that market by increasing the protein content.

A manuscript is in preparation closing out this project.

W. E. Paulson and G. S. Fraps.

Operating Costs and Financial Conditions of Gins in Texas

(In so far as this study deals with cooperative gins, the project is in cooperation with the Cooperative Division, Farm Credit Administration)

Progress Report No. 570, "Cost of Ginning," (in mimeograph) was issued during the year. This analysis is based on 382 cost records. Not that many gins are represented, however, as in many instances cost records on individual gins cover a number of seasons.

The gins were grouped according to size and type of power. Costs of ginning were segregated under the following headings: labor, power, repairs, insurance, taxes, depreciation, management, office salaries, and miscellaneous. These cost items, as well as their totals, were correlated with volume of ginning and investment in the gin plant. An estimating equation was computed for each gin group. In the various gin groups, the variables—volume of ginning and investment in the gin plant—accounted for variations in total costs of ginning as follows: 5-stand steam plants, 80 per cent; 5-stand Diesel plants, 70 per cent; 5-stand electric plants, 86 per cent; and 4-stand Diesel plants, 75 per cent.

By means of these equations, tables of estimated costs, total and per bale, for each of the gin groups, were computed. These tables enable the ginner to find the standard cost of ginning for his particular size of gin, type of power, volume of ginning, and investment in the gin plant. Then by comparing his actual cost of ginning with the estimated, the ginner may determine his own relative efficiency in terms of the standard set by the whole group of gins.

About 475 additional cost records were obtained during the year. A very large portion of these records are on gins in East and Northeast Texas. A sufficient number of cost records have now been obtained to make possible the analysis of ginning costs for the areas East Texas and West Texas.

L. P. Gabbard and W. E. Paulson.

Factors Affecting the Equitable Assessment of Rural and Urban Property in Texas

This project proposes to deal specifically with factors affecting assessments, with the view of suggesting measures for the correction of existing inequalities. During the year, data relative to the average annual tax per acre on farm lands were extended from 1933 to 1936, inclusive, and the number of counties included in the study was increased from 160 to 197. These data were summarized, and a mimeographed report, entitled "Trend of Taxes on Farm and Ranch Real Estate in Texas, 1913-1936," showing (1) the trend of taxes on farm and ranch lands in the State as a whole, (2) the trend for each of the major type-of-farming areas, and (3) the trend for each of the 197 counties, was issued. This report supplements Texas Station Bulletin No. 512, "Trend of Taxes on Farm and Ranch Real Estate in Texas." The inclusion of additional counties made it necessary to recalculate figures in which the State or type-of-farming areas are involved. For this reason this report, as compared with Bulletin No. 512, shows slight changes from year to year in the average tax per acre, tax index, tax ratio for the State, and in the average tax per acre by type-of-farming areas.

During the twenty-four year period 1913-1936, taxes per acre were highest in 1931 and lowest in 1913. If, however, taxes per acre are related to the prices of farm products, the picture is somewhat changed. On such a basis, taxes were lowest in 1918 and highest in 1932. On the basis of the ratio of taxes to the prices of farm products, there has been a marked decline in farm taxes in Texas since 1932. The most marked decline occurred during 1933 and 1934. As will be observed, there has been no significant change in the level of farm taxes in Texas during 1935 and 1936. Both absolutely and relatively, taxes on farm lands in Texas were about twice as high in 1936 as in 1913.

The following table shows the trend of taxes on farm and ranch lands in Texas and their relation to farm prices for the period 1913 to 1936, inclusive. The ratio is a measure of the burden of taxes in terms of the prices received for farm commodities. It will be observed that taxes were almost five times as high in 1932 as in 1913 but were only twice as high in 1936 as in 1913.

Farm taxes per acre, indexes of farm taxes, indexes of farm prices and ratio of farm taxes to farm prices, 1913-1936

Year	Tax per acre cents	Tax index	Price index	Ratio tax index to price index
1913.....	8.6	100	100	1.00
1914.....	8.8	102	95	1.07
1915.....	10.2	129	93	1.39
1916.....	10.0	116	120	.97
1917.....	11.8	137	177	.77
1918.....	12.6	147	220	.67
1919.....	16.2	188	222	.85
1920.....	16.7	194	217	.89
1921.....	17.4	202	105	1.92
1922.....	18.9	220	132	1.67
1923.....	19.9	231	167	1.38
1924.....	20.7	241	166	1.45
1925.....	21.9	255	156	1.63
1926.....	22.3	259	126	2.06
1927.....	23.5	273	129	2.12
1928.....	23.8	277	150	1.85
1929.....	25.0	291	145	2.01
1930.....	25.5	297	109	2.72
1931.....	26.5	308	70	4.40
1932.....	21.4	249	51	4.88
1933.....	20.1	234	64	3.66
1934.....	17.9	208	90	2.31
1935.....	16.9	197	102	1.93
1936.....	17.0	198	101	1.96

L. P. Gabbard and H. C. Bradshaw.

Factors Affecting the Collection and Expenditure of Taxation Revenues in Texas

This project is designed to study the administration of State and local taxes as they affect the farmer. In order to show the possibilities of reducing farm taxes through improved assessment of property and through improved management of government in general, it is necessary to consider the administration of taxes in a very broad sense. Although the work of assessment and collection is of primary interest, it is also necessary to study such related activities as budgeting or financial management, accounting and auditing, and financial reports.

As one phase of the study, a comparison has been made of the costs of operating the assessor-collectors' offices in the 254 counties in 1935. These costs were taken from the fee reports filed by these officers with the State Auditor and Efficiency Expert. The following table shows that the per capita cost of assessing and collecting is considerably higher in small than in large counties. Thus, the least populous counties, which are entirely rural, have relatively higher costs for this office than have the larger and more urban counties. This difference is partially accounted for by the method used to finance the office. The assessor-collector is a fee officer; that is, the officer is allowed to retain a certain percentage of tax collections in order to pay his salary and in general to operate the office. The schedule of fees is so arranged that the highest fees are paid

for the first collections. Consequently, as total collections increase, the percentage of such collections which is retained as fees decreases.

Cost of operating 254 county assessor-collectors' offices in 1935

(With counties grouped according to population.)

Population group	No. of counties	Total population	Total cost	Cost per capita
0—4,599.....	46	124,871	\$ 198,894	1.59
5,000—9,999.....	49	350,778	346,399	.99
10,000—14,999.....	48	591,489	351,036	.59
15,000—19,999.....	29	511,759	273,486	.53
20,000—24,999.....	21	476,288	204,858	.43
25,000—29,999.....	12	336,508	128,255	.38
30,000—34,999.....	13	413,685	174,247	.42
35,000 and above.....	36	3,019,337	1,233,922	.41
Grand total.....	254	5,824,715	\$ 2,911,097	.50

According to the above table, the per capita cost for this office declined from \$1.59 in counties having less than 5,000 population to 41 cents in counties having more than 35,000 population. The average per capita cost for all offices was 50 cents. As has been stated, this difference in costs is partially accounted for by the scale of fees by which the office is financed. Other factors having an important bearing on the costs of these offices include the training and experience of the officials and the amount of tax delinquency in the various counties. These factors are not subject to exact measurement, but further research is expected to show substantially how they work out.

L. P. Gabbard and H. C. Bradshaw.

The Economic Significance of Different Farm Leasing Systems in Texas

Six hundred forty-four tenant farm records from field surveys or from farm record books have been analyzed. They indicate the following:

In East Texas, the landowner income represented 18 per cent of the farm income. They represented 27 per cent in the Black Prairie, 32 per cent in the Low Plains, and 31 per cent in the High Plains. These differences in owner incomes are partially due to the fact that the family living of the tenants in East Texas makes up a greater proportion of the total income than it does in West Texas.

These records seem to indicate that in different regions of the State there exist different means of the tenant increasing his income, as for example; in cases where he can grow most of his living at home he has a saving, and in areas where he can work larger acreages of land he has a chance of increasing his individual income. In neither of these two cases is the landowner's income increased correspondingly.

It is suggested that the use of livestock and the inclusion of it in the lease as a product to be shared with the landowner, would enhance the

tenant's opportunities for an abundant home living on the farm as well as give him some source of cash income from crops now usually wasted on Texas farms. Not only would it give the tenant greater advantages and income, but, also, it would yield to the owner a better return for the use of his land.

These and other significant leasing systems are being studied with the view of giving both tenants and owners better advantages and better incomes.

L. P. Gabbard and C. H. Hamilton.

Additional Cooperative Projects

Farm Population Changes. This division has made, in cooperation with the Division of Farm Population and Rural Life, Bureau of Agricultural Economics, U. S. D. A., a survey of farm population changes in Texas during 1937. A mimeographed report of this survey is available in the Division of Farm and Ranch Economics of this Station.

Farm Mechanization and Labor Changes. In cooperation with the Works Progress Administration, a study of farm mechanization and labor changes has been made on 525 farms and plantations of representative Texas counties. The report on this project will be issued from Washington, but some of the data will also be used in the Experiment Station's study of farm leasing systems.

Unmet Needs for Public Assistance. Another cooperative project with the Works Progress Administration has been a study of unmet needs for public assistance in three representative Texas counties—Upshur, Collin, and Fisher. This study is repeated at least twice each year and reveals valuable first-hand information about the social and economic conditions of rural people in those areas of Texas. The Federal WPA has used the results of these studies as a basis for allocating funds for rural work projects.

In addition to the above cooperative studies, the Farm Security Administration assisted with the WPA study of farm mechanization and labor changes. The Farm Security Administration made it possible to increase the size and scope of the study and to survey 625 farm laborers during the cotton picking season of 1938. This study will be reported upon at more length during the year.

C. H. Hamilton and W. C. Holley.

BOTANY

The identity and distribution of native vegetation is of considerable importance to the study of agricultural problems. Vegetation is an important item in furnishing feed for livestock. Some species of vegetation when eaten are harmful to livestock. Many species have value as honey

producers. Plants also act as carriers of plant diseases and in this way have an important relation to agriculture.

The study of native vegetation in relation to livestock industry is centered around the work at the Ranch Experiment Station. It involves principally the occurrence of species which make up the range feed values and the occurrence of species which are harmful to livestock or have low range feed values. The study of the sequence of the different species also widens our knowledge of the extent to which these may affect range feed values.

The work in connection with honey plants is centered at the Apicultural Research Laboratory near San Antonio and is reported under the Division of Apiculture.

The study of vegetation as carriers of plant diseases is centered at Substation No. 5, Temple, primarily in connection with cotton root rot disease work. Some additional work with plants as weed pests is being carried at the Winter Garden Station and at the Apicultural Research Laboratory.

SWINE HUSBANDRY

The Relationship of Genetic Factors to Vitamin A Requirements in Mammals

(In cooperation with School of Agriculture, A. & M. College of Texas)

The object of this project is (1) to determine if the expression of certain genetic factors is dependent on the level of vitamin A in the ration and body tissues; and (2) to find whether or not genetic factors affect the utilization of vitamin A by the tissues; and (3) to find whether or not a strain of animals can be produced that will remain free from anomalies of development when raised on relatively low levels of vitamin A.

Several groups of rats have been tested for the time required to show symptoms of A deficiency. Some variation was noted and selection has been made of those showing the shortest period and those showing the longest period before exhibiting A deficiencies. These lines are being continued and will be tested each generation. Attempts to produce eyeless rats from normal stock by feeding A-deficient ration have as yet been unsuccessful. These studies are being continued as the number of litters obtained to date has been small. Tests are now being made to determine if the level of A intake affects the percentage of eyeless young born to a genetic strain of rats showing a high incidence of eye anomalies.

J. H. Quisenberry, F. Hale.

Calcium Requirements of Pigs Fed Rations Balanced with Cottonseed Meal

Two tests with two groups of ten 62-pound pigs each were fed individually for 90 days, a ration composed of kafir, cottonseed meal, alfalfa leaf

meal, oyster shell flour and salt. The oyster shell flour contained 54.57 per cent CaO. One group received 1 per cent, the other groups 2 per cent of oyster shell flour in the ration. The pigs getting the 1 per cent oyster shell made greater gains and required less feed per pound of gain than did the pigs getting the 2 per cent of oyster shell flour. A third group of two pigs that received no oyster shell flour in the ration gained only 75 per cent as much as did the pigs getting 1 per cent oyster shell. The results indicate that the ration used in these tests needs less than 2 per cent oyster shell flour as a source of calcium.

F. Hale.

Quantitative Requirements of Vitamin A for Pigs

Twenty-one pigs were used in this study this year. Seven pigs in each of three groups were fed individually from January 21, to November 11, 1938. One group received a ration containing 35 micrograms of carotene in the form of alfalfa leaf meal, one group 70 micrograms, and the third group 180 micrograms of carotene per 100 grams of feed. There was no significant difference in the average daily gains, or the economy of gains between the groups. Other tests will be made to determine if fattening pigs require less than 35 micrograms of carotene per 100 grams of feed for economical gains.

F. Hale, G. S. Fraps.

Sudan Grass and Oats Pasture for Fattening Hogs

One 90-day test was conducted with sudan grass and one with oats pasture this year. Ten pairs of pigs were used in the sudan grass pasture test, while two groups of 13 pigs each were used in the oats pasture test.

The oats pasture experiment was conducted in December, January, and February. The average daily gain of the pigs on oats pasture was 1.78 pounds, while the pigs without oats pasture gained 1.92 pounds per day. The oats pasture, however, caused a saving of 832 pounds of protein supplement per acre for the 90-day period. This saving amounted to \$16.64 per acre for this short period. This test, and our previous work, shows that fattening pigs will gain as well in dry lot, but a good oats pasture will cause a saving of about 50 per cent of the protein supplement part of the ration.

The sudan grass experiment was conducted in June, July, and August. Ten pairs of pigs, fed individually, with one pig given access to an individual lot of sudan grass pasture, were used in this 90-day test. The sudan grass caused a saving of 213 pounds of protein supplement and 140 pounds of grain per acre for the 90-day period. The gains were slightly greater with the pigs on the sudan grass.

F. Hale.

Concrete Hog Wallows for Fattening Hogs

Ten pairs of pigs were used in this 90-day test. One pig in each pair had access to an individual concrete hog wallow. All pigs were self-fed the same kind of feed in individual pens. The average temperature during the months of June, July, and August, when this test was conducted, was 83° F. All of the pigs had access to shade.

The ten pigs that had access to the concrete hog wallow made an average of 14 pounds more gain per pig, and required 10 pounds less feed per 100 pounds of gain than did similar pigs without access to the hog wallow.

F. Hale.

DAIRY HUSBANDRY

Dried Citrus Peel and Pulp in the Ration of Lactating Cows

(In cooperation with School of Agriculture, A. & M. College of Texas)

There have been two 90-day experiments conducted during the year comparing a grain mixture where dried citrus peel and pulp comprised 50 per cent of the total grain mixture with a similar grain mixture with ground corn and cob meal replacing all of the citrus peel and pulp. In these two tests there was no significant difference in the amount of milk produced by cows fed the two grain mixtures. These results indicate that dried citrus peel and pulp and corn and cob meal have approximately the same productive energy value for lactating dairy cows.

O. C. Copeland and C. N. Shepardson.

Variations in Normal Composition of Milk Produced in Texas

(In cooperation with School of Agriculture, A. & M. College of Texas)

In this investigation the work has thus far been preliminary in nature, including:

The designing and/or securing of equipment suitable for the analyses to be conducted; perfecting the methods of analysis, particularly the adaptation of the Micro-Kjeldahl nitrogen procedure to the determination of protein in milk; calibration of volumetric and other quantitative glassware to be used in the chemical analyses; a detailed study and planning of a method for securing samples and for recording and reporting the analytical data obtained.

C. N. Shepardson and T. R. Freeman.

Permanent Pastures for East Central Texas

The results of three year's yields from bermuda grass plats treated with various fertilizers indicate that nitrogen is the most important fertilizer constituent for pasture production. The yields from plats treated with manure were greater than plats treated with any commercial fertilizer.

O. C. Copeland and E. B. Reynolds.

The Quantitative Requirements of Vitamin A for Dairy Cattle

This project has been continued as outlined in previous reports. Three groups composed of six heifers each have been fed on levels of 1,000, 2,000, and 2,500 micrograms of carotene per 100 pounds liveweight since approximately five months of age. Heat dried alfalfa meal is being used as the source of carotene or vitamin A. Body measurements and live-weights are taken at regular intervals to measure rate of growth. The experiment has not progressed far enough to present definite conclusions, however, the heifers on the two higher levels have made faster gains than the heifers fed on the level of 1,000 micrograms. Breeding performance has also been more satisfactory on the higher levels of carotene feeding. Night blindness has been observed in all of the heifers which indicates that possibly 2,500 micrograms of carotene is not sufficient to adequately supply the vitamin A requirements.

Two experiments have been completed comparing the effect of levels of 1,500 and 15,000 micrograms of carotene per 100 pounds liveweight on milk yield. In both experiments there was about 10 per cent more milk produced on the higher level of carotene feeding.

O. C. Copeland and G. S. Fraps.

Bangs Bacillus Disease (Bovine Infectious Abortion)

Details of this project can be found in the report of the Division of Veterinary Science.

H. Schmidt and O. C. Copeland.

Cottonseed Meal and Hulls As a Ration for Lactating Dairy Cows

This project has been completed and the results are being analyzed for publication as a Station bulletin. Satisfactory milk production was obtained from cows fed on cottonseed meal as the sole concentrate when supplemented with pasturage. Cottonseed hulls or sorghum silage were not satisfactory replacements for green feed in this experiment because they did not furnish sufficient vitamin A for good health, a normal milk yield, or average breeding performance.

O. C. Copeland.

Factors Affecting the Quality of Southern Short Cure Cheese

(In cooperation with School of Agriculture, A. & M. College of Texas)

Preliminary trials indicated that high temperature of curing was the most promising factor studied, therefore, the project was revised in 1938 to study this factor in detail.

Seaminess in several lots of cheese was traced to milk which had been excessively agitated thus causing a churned condition of the fat. Rinsing the milled curd with warm water did not prevent seaminess.

F. E. Hanson and C. N. Shepardson.

Methods of Manufacture and Other Factors Affecting the Quality of Butter

(In cooperation with School of Agriculture, A. & M. College of Texas)

During the past year considerable time and effort have been spent in developing methods of technique adequate for conducting various tests for measuring the quality of butter.

Preliminary results indicate that the fat, moisture and salt contents of butter made in some creameries vary considerably from one month to the next. Analyses of butter show that the fat content and also the hardness were greater in late summer and fall than in the spring.

Cows fed a ration containing cottonseed meal and hulls produced harder butter than those fed a ration containing cottonseed. Butter produced by Jersey cows was firmer than butter produced by Holstein cows.

F. E. Hanson and C. N. Shepardson.

POULTRY HUSBANDRY

Vitamin A Requirements of Chicks

Studies on the Vitamin A requirements of chicks conducted in cooperation with the Division of Chemistry show that 100 to 125 micrograms of carotene per 100 grams of feed gave as low mortality, satisfactory health and as large gains in liveweight as did higher levels of carotene. There seemed to be no evidence in these studies that pure carotene had a different efficiency than carotene in alfalfa leaf meal.

Vitamin A Requirements of Hens

In one experiment with hens receiving 200, 300 and 400 micrograms of carotene per 100 grams of feed, the mortality was lower, the egg production was higher and the feed required to produce eggs was lower as the levels of carotene increased. In another experiment with hens receiving 150, 225 and 300 micrograms of carotene per 100 grams of feed, the results varied with the carotene feeds as reported above.

R. M. Sherwood, G. S. Fraps.

Vitamin D Requirements of Chickens

Work was continued on this project in cooperation with the Division of Chemistry. Four experiments were conducted with three levels of phosphorus and approximately the same level of calcium. In three of these experiments the phosphorus levels were 0.67, 0.77 and 0.87 per cent and the calcium varied from 1.44 to 1.50 per cent. These levels of phosphorus were fed with three levels of Vitamin D from cod liver oil and in one experiment the chicks were allowed an average of 1.4 hours of direct sunlight per week for ten weeks the duration of these tests. Increases

in phosphorus above .67 per cent had very little effect upon the gains in liveweight of the chicks or in the grams of feed required to produce a gram of gain in the experiments receiving vitamin D from cod liver oil. However, there was an increase in the percentage of bone ash and a decrease in the incidence of crooked breast bones and rickets in the groups receiving 0.77 and 0.87 per cent phosphorus over those receiving 0.67 per cent phosphorus. In the experiment where the chicks were allowed an average of 1.4 hours of sunlight per week, there was an increase in the gains in liveweight with each addition of phosphorus, and very satisfactory growth was obtained. The values for the mean percentage bone ash approximated those of the groups receiving vitamin D from cod liver oil.

One experiment was conducted for a period of six weeks in which .63, .73 and .83 per cent phosphorus was fed with 1.46-1.51 per cent calcium. Representative chicks were killed from each group each week for bone ash analysis until the close of the experiment. No vitamin D was fed and the chicks were not allowed access to sunlight. There was an increase in the mean percentage bone ash with each addition of phosphorus throughout the experiment. There was a decided drop in the bone ash of all groups at the end of the fourth week. The mean percentage of bone ash at the end of the test for the groups receiving .63, .73 and .83 per cent phosphorus was 32.12, 37.20 and 38.11 respectively. It may be concluded that the bone ash of chicks may be increased during the first six weeks in the absence of vitamin D by feeding increased amounts of phosphorus up to .83 per cent.

J. R. Couch, G. S. Fraps, R. M. Sherwood.

Effect of Sulphur on the Carotene Requirements of Chicks

Ten experiments were run with chicks in cooperation with the Division of Chemistry in order to study the effect of sulphur on the carotene requirements of chickens. Amounts of carotene ranging from 50 to 150 micrograms per 100 grams of feed were studied with and without sulphur. Six experiments were conducted on seven hundred and fifty micrograms of carotene with and without sulphur. In some cases, cod liver oil was used to supply vitamin D while in other cases chicks had access to sunshine. Sunshine was much more satisfactory for a supply of vitamin D than cod liver oil. Gain in liveweight, percentage of bone ash, feed efficiency and mortality were all studied, but conclusive results are not yet available. The work is being continued.

R. M. Sherwood, G. S. Fraps, J. R. Couch.

Slipped Tendons or Perosis Study

Two experiments involving a total of 624 chicks were used to study, in cooperation with the Division of Chemistry, the effect of the addition of 20, 40 and 60 parts per million of manganese as the sulphate to a basal ration used at this Station and recommended to poultrymen of this State. The basal ration was composed of 6 per cent vacuum-dried sardine meal,

6 per cent soy bean oil meal, 6 per cent cottonseed meal, 0.5 per cent salt, 1.25 per cent poultry bone meal, 2.5 per cent chick size oyster shell, 30 per cent wheat gray shorts, 3 per cent dehydrated alfalfa leaf meal, 44.62 per cent ground milo and 0.13 per cent fortified cod liver oil. The manganese content of the basal ration in the first experiment was 57 parts per million and in the second experiment was 35 parts per million. This wide variation is attributed to the different lots of the various feeds that were used in the second experiment than were used in the first experiment. The basal ration contained 1.66 per cent calcium and 0.82 per cent phosphorus with a calcium-phosphorus ratio of approximately 2:1. New Hampshire chicks were used in our experiments; the duration of the experiments was ten weeks. There were no differences between the control and groups receiving either of the three levels of manganese in gains in liveweight, grams of feed required to produce a gram of gain or percentage of the chicks that died during the experimental period. There was no perosis in any of the groups.

R. M. Sherwood, G. S. Fraps.

Calcium and Phosphorus Requirements for Chicks

Two experiments involving 450 chickens, fifteen different levels of calcium and three levels of phosphorus were studied with New Hampshire chicks from one day old to ten weeks of age. The basal ration used was composed of 6 per cent vacuum-dried sardine meal, 6 per cent soy bean oil meal, 6 per cent cottonseed meal, 5 per cent ground whole oats, 3 per cent dehydrated alfalfa leaf meal, 0.5 per cent salt, $\frac{1}{8}$ per cent fortified cod liver oil, 20 per cent wheat gray shorts and 53 $\frac{3}{8}$ per cent ground yellow corn. Chick size oyster shell and poultry bone meal were the carriers of calcium and phosphorus that were used. The levels of calcium fed varied from 0.98 to 2.05 per cent and the levels of phosphorus were 0.66, 0.77 and 0.87 per cent. Gains in liveweight, grams of feed required to produce a gram of gain, and incidence of slipped tendons were criteria used in analyzing the results. It would appear from the data of these tests that growing chicks require approximately 1.5 per cent calcium and 0.77 per cent phosphorus for maximum growth, efficient utilization of the feed and prevention of slipped tendons.

R. M. Sherwood, J. R. Couch.

RURAL HOME RESEARCH

Effect of Tea Upon the Energy Metabolism of Children

The increase in oxygen consumption by children 10 to 13 years of age following ingestion of 300 cc of ice tea (average amount of caffeine .0292 gram) as compared with 300 cc of lemonade containing the same amount of lemon juice and sugar, is measured by a Benedict-Roth recording respiration apparatus.

In the first series of 6 or 7 tests with each of 8 children who differed in habit of consuming foods containing caffeine and theobromine, very little

increase due to the caffeine was observed in any case and no child had a consistently higher rate after tea. A second series of tests has been started in which the factor of tolerance is being taken into account. The child abstains for a week from all foods containing caffeine or theobromine before the tests with tea are made. Tests with both beverages are repeated following a period of daily ingestion of tea of the same strength as used in the experiment. Tests with two children have been completed, with two others begun, and are planned for several others.

Jessie Whitacre.

Factors Affecting the Storage of Cucumbers

A manuscript has been prepared giving the complete report of this project, a cooperative one since 1935 with the Division of Horticulture which began the study in 1933. It was found that cucumbers wrapped individually in moisture proof cellophane, or packed unwrapped in a shipping container lined with the cellophane, or placed unwrapped in a refrigerator humidifier, and stored at a temperature of 35 to 40° F. remained, for at least eight days, practically as desirable as freshly harvested fruits. For two weeks most of them were quite acceptable though not in choice condition.

Jessie Whitacre, L. R. Hawthorn, S. H. Yarnell.

The Mineral Composition of Vegetables Grown in Representative Regions of Texas and the Relation of Variations in Mineral Content to the Probable Nutritive Value

The object of this joint project of the Divisions of Rural Home Research, Horticulture and Chemistry, and cooperative with other southern states, the U. S. Plant Breeding Laboratory in Charleston, South Carolina, Texas Technological College, Texas State College for Women, and the University of Texas, is to determine the content of calcium, phosphorus, copper, and iron in vegetables grown in different regions of the south and to interpret the findings as they relate to human nutrition. The same variety of each vegetable from seed supplied by a common source will be grown in each place. The work has started with the use of Seven Tops turnip greens and Cream Crowder peas. In Texas, vegetables are being grown by the Experiment Station at Iowa Park, Winter Haven, and College Station and by Texas Technological College at Lubbock. The first crop of turnip greens is ready for chemical analysis; the first crop of cowpeas will be grown in the spring of 1939.

Jessie Whitacre, S. H. Yarnell, G. S. Fraps,
L. R. Hawthorn, B. S. Pickett.

The Effect of Oven Temperatures on the Tenderness of Meat

Highly significant differences in tenderness have been produced in paired roasts by using oven temperatures of 80° C. (below the boiling point of

water) and 125° C. (as low as possible without special adjustment of the gas). The lower oven temperature produced much the more tender roast but required approximately 24 hours total cooking time or 15 to 20 hours longer than the roast cooked at the higher oven temperature.

The same oven temperature (125° C.) was used for cooking paired roasts, but one roast was cooked in a well ventilated oven and the other in a poorly ventilated oven (the humidity was very high and the air flow very low—conditions similar to those occurring when a roast is cooked on top of the stove in a heavy covered pot without added water). The roasts cooked faster in the poorly ventilated oven but were less tender. This difference in tenderness was highly significant.

The results of these experiments add further proof of the importance of slow cooking in producing more tender roasts, whether the slower cooking is obtained by oven temperature or by other means.

Sylvia Cover.

Processing of Canned Meat

Equipment has been constructed for obtaining temperatures inside a can of meat. The data collected will be used to determine the processing time required to make the meat safe for human food.

Sylvia Cover, H. Schmidt, and R. D. Turk.

Beef-Cattle Husbandry Investigations Relating to the Fattening of Steers at Different Levels of Feeding

The results of the physical separations and the chemical analyses from the Big Spring steers are found under the Division of Range Animal Industry.

Sylvia Cover, J. M. Jones, F. E. Keating.

The Effect of Degree of Fatness on Tenderness of Lamb

(In cooperation with School of Agriculture, A. & M. College of Texas)

In the first series of tests carried on in the fall and winter of 1937-38, a subjective method of testing tenderness using a five-point scale of weighted adjectives was employed. The results were of doubtful significance because of the finding of a highly significant difference between the tenderness judgments of different judges.

For the second series of tests carried on in the late winter and spring of 1938, the project was revised so that the paired eating method could be used for testing tenderness—comparing a fat lamb carcass with a thin one. A difference in tenderness was then observed between the fat and thin lambs which was in favor of the fat lambs. Statistical analysis showed that this difference was highly significant, but the individual lambs in each pair differed in other respects as well as in fatness.

In the test now in progress the plan was improved by pairing the lambs individually before placing them on feed. The characteristics considered important in pairing were: breed, body type, muscling, size and weight. One lamb of each pair was placed in a lot receiving full feed in an effort to give them a high degree of finish. The other lamb of each pair was placed in a lot receiving a smaller amount of similar feeds sufficient only to keep them in a healthy and slightly gaining condition. The feeds used are the same as last year; shelled corn, cottonseed meal, and alfalfa hay. Each pair of lambs will be tested for tenderness by the paired eating method. The test is unfinished and no results are available.

Sylvia Cooper, A. K. Mackey, and C. E. Murphey.

Physical Characteristics in Cotton and Their Interrelationship

Lightning Express and Half and Half, with succeeding generations of hybrid lines resulting from a cross of these two varieties are being used. The cotton was furnished by the Division of Agronomy.

With the exception of the strength determinations, the measurements were made from fibers from one seed from each lock within one boll from each plant. This material thus far includes five plants for each parent, 10 for the back cross, three for the F_1 and 50 for the F_2 generations.

From the fibers thus far examined it was found that the percentage of mature fibers in Half and Half is 79, Lightning Express 71, the back cross of Lightning Express and F_1 80, F_1 72, and F_2 77%. The longest and the shortest fibers are less mature than those of intermediate length. The mean length of Half and Half is 0.74, Lightning Express 1.04, the back cross 1.04, F_1 0.93, and F_2 0.94 inches. The upper quartile length of Half and Half is 0.88, Lightning Express 1.23, back cross 1.24, F_1 1.08, and F_2 1.10 inches. The average area of the cross sections of 3500 fibers of each variety, taken from the five plants of each parent, is 165 square microns for Half and Half and 120 square microns for Lightning Express.

The weight per inch is 5.7 micrograms for Half and Half, 3.9 for Lightning Express, 3.7 for the back cross, 4.7 for F_1 , and 4.5 micrograms for F_2 .

The breaking strength of Half and Half is 66,000 pounds per square inch, of Lightning Express 82,000, of the back cross 78,000, of F_1 approximately 76,000 pounds.

Mary Anna Grimes.

Study of Body Measurements for Sizing Children's Garments and Patterns

(In cooperation with 14 States and with the Bureau of Home Economics, U. S. D. A.)

Collection of data on this project was completed in the past year. Records for over 4,000 children of 6 to 14 years have been secured and the total mass of data brought to nearly 8,000 cases. Measurers especially trained by an anthropometrist in the technique used, made 36 different body measurements of each child. The children measured were enrolled in the schools of Denton, Dallas, Lubbock, San Antonio, and Houston.

In the analysis of data, the Bureau of Home Economics is taking the lead with respect to the derivation of the first scientific basis for standardizing children's garments and patterns. The primary interest of the Division of Rural Home Research in analysis of the Texas data (just begun) is the relationship of body size and proportion to socio-economic level and to the natural environment of the localities represented.

A subsidiary study of the information secured from the children and that from parents or other adults regarding the occupation that provides the family support, showed the children of all ages to be as reliable a source of information as any other.

Jessie Whitacre.

APICULTURE

The Apicultural Research Laboratory is located near San Antonio with yards near Dilley and Roxton.

Activities of Bees

The basic work of this Laboratory is the recording of the response of the honeybee to the various phases of the weather. Continuous observations augmented by recording instruments give the fluctuations of temperatures, humidity, barometric pressure, light conditions, wind direction, and rainfall, together with a variation in weight of the two hives under experiment. These data, when translated, give a complete picture of the activities of the honeybees as it is controlled by the varying weather conditions. The year 1938 began with a dry warm period. While the bees had ample stores, there was little rainfall, consequently no early spring flow. Brood rearing was greatly retarded due to the lack of new nectar and pollen from the field. A month later than usual brood rearing began under the same influence that produced the first general bloom of spring plants. On April 7 the bees had reached a high worker population and plants, sufficient numbers to supply a honey flow. On this date a severe norther accompanied by high winds not only destroyed the honey plants above the ground but killed many of them outright. The bees suffered the loss of much brood. This curtailing of plants and of brood rearing brought on a heavy honey flow and a large crop of worker bees

approximately one month later. Weather conditions were good and during the months of May and June a normal crop of horsemint-mesquite honey was made. Commencing with the latter part of May and extending to the last week in December an ever increasing drought put an end to any activity on the part of the bees. The responses to adverse conditions reveal the great adaptability of the honeybee to weather conditions. The stores in the hives were ample. These, however, were scarcely touched by the bees during the summer months. The lack of new nectar and pollen did not allow the rearing of a large winter force of workers. With the coming of cooler weather when the bees ordinarily are at work collecting the fall honey crop, as none existed they put in their time in replacing the spring honey around a small brood nest in such a manner as to make this honey an ample insulation against cold. Large amounts of propolis composed of resin of various trees and plant hair from the leaves of Mexican Persimmon were used in making the hives air and water tight. By the middle of October, though no clustering temperatures occurred, the bees were as quiescent as in the middle of winter. This condition continued until the twentieth of December when a rainy period lasting five days caused many of the semi-arid plants to resume growth. During the few remaining days of the year honeybees have been very active carrying water into the hives. This indicates that they will commence brood rearing very shortly. A chart composed of horizontal columns representing the days of the month and the perpendicular columns showing the months when filled with the mean temperatures below 57 degrees Fahrenheit and above a maximum of 94 degrees Fahrenheit gives a very accurate picture of the activity of bees. Those above 94 indicate that the bees are somewhat inactive due to high temperatures while those below 57 indicate the bees are inactive due to cold. The blank space shows the periods of activity.

H. B. Parks.

Adaptability of Native Plants

A heavy increase of interest in the use of native plants has made heavy demands on this Station for information as to new plants adapted to various uses and for additional uses of plants already well known. Many new plants were brought in for trial or placed under observation. As the object of trials made here is to ascertain the life cycle, the manner of growth, and habitat, often continuous observations on certain plants in their natural location are of more value than the attempt to grow the plant under new conditions.

Sweet Clover, *Melilotus alba* var. *annua*. The endurance plat of the variety of white sweet clover commonly known as Hubam made a heavy growth and crop of seed this year, demonstrating that this clover is a most excellent honey plant, a forage plant of value, excellent for soil improvement and is as dependable as any crop that can be raised on the sandy soils of the Gulf plains of Texas. This clover was visited by bees for nectar and pollen from April 24 until June 12. The honey stored during

that period of time in this vicinity had the characteristic flavor of northern sweet clover honey.

Amoreuxia Wrightii A. Gray. This plant, which seems to be without a common name, first came to the attention of this Station when a small plant much resembling a castor bean seedling was discovered in a Pleistocene lake bed in the city of Corpus Christi. Several of these small plants were collected and submitted to authorities for identification without success. In the fall of 1936 another lot of plants was collected and these were submitted with the same result. In 1937 another plant bearing a single seed capsule was found. The plant previously considered to be an annual was carefully excavated and was found to be a perennial with a very deep tuber. This plant was removed to the Laboratory and in the spring of 1938 it made every preparation for blooming but failed due to the drought. Attention of this plant was called to a florist who was making a trip by automobile to Mexico. On the return trip some collecting was done near Laredo and specimens of this plant were found in bloom. On comparison there was no doubt as to the identity of the plants from Corpus Christi. The Mexican specimens were identified at the Arnold Arboretum as *Amoreuxia Wrightii*. Knowing the appearance of the adult plant a trip was made to Corpus Christi in the latter part of May and after much search two plants in full bloom and fruit were discovered. The plants above ground were used as herbarium specimens. The tubers were brought to the Laboratory and would have bloomed again this year if moisture conditions had been right. The Laboratory now has four living tubers and hopes to be able to obtain flowers and seed in 1939. This plant seems to have been collected somewhere in Texas along the Rio Grande River. No definite information as to where the original collections were made can be found nor any information obtained as to where it grows in Texas other than the lake bed at Corpus Christi. The plant has the following possibilities: perennial, annual above ground, the foliage of the plant being quite ornamental, the flowers which are two and one-half inches in diameter are of golden yellow with a purple center to each petal. These flowers are borne abundantly through a period of about a month. The entire plant has a height of more than fifteen inches. The seed pods are quite large, being three-fourths of an inch wide and one and one-half inches long.

Amaryllidaceae. Due to the peculiar life cycles of the members of this family and to the confusion that exists in the definitions of genera and species both in Amaryllidaceae and Iridaceae as many Texas species as can be obtained are in the plats here and others are being brought in as fast as they can be procured. These groups, most of which are natives of the semi-arid section, go through their blooming period with such rapidity that it is possible for plants to be extremely common and yet their flowers to be entirely unknown. This is very true of certain genera which grow in large societies and only bloom under certain very definite weather conditions. It is known that there are at least two or

three species whose bulbs and blades are very abundant throughout the Gulf plains that are probably new to science as up to date no definite information is at hand as to the flower. As these groups contain species that are extremely ornamental and of easy growth any additional information as to their life cycle and growth habits is of value.

Berberis Swazeyi Buckl. This is an evergreen perennial which somewhat resembles the ordinary agarita. While an evergreen the leaves are not so coriaceous or the spines so definite as those of *Berberis trifoliata*. The leaves are longer, the number of leaflets greater, the midribs bright red and the leaf deep green. The plant gives indication of being excellent for use in hedges or as specimen plants for ornamental purposes. It will rank with holly if experiment shows that the plant will bear heavy pruning.

The Genus Polypteris. Additional study of this genus emphasizes the fact that its various members are all adapted for ornamental purposes. Their showy red composite flowers, most of which bloom in the fall, are of easy culture and bloom for a period of from two to three months. The flower clusters vary from one-half inch to two inches in diameter. The plant grows easily in any kind of soil. The seed, however, should be sown in November or December. *Polypteris cymosa* Ness is known only from the type locality near College Station. It blooms throughout a period of six weeks in midsummer, has a smooth green foliage and bright red cymose flower clusters. This plant is an addition to any summer garden as it blooms through midsummer with a minimum of attention.

H. B. Parks, A. H. Alex.

Queen Rearing

The strain of honeybees which has been brought into existence by continual inbreeding and selection at the Laboratory was continued in so far as breeding material was needed and for keeping the strain pure and hives supplied with young queens of known parentage. There is no immediate demand for a large number of queens from this strain or is time available for measurement to ascertain if there is any increase in size or carrying capacity. The high resistance to the attacks of larvae of wax moth and superior honey gathering ability makes this race very desirable.

A. H. Alex, H. B. Parks.

Breeding for Resistance to American Foulbrood

(In cooperation with Bureau of Entomology and Plant Quarantine,
U. S. Department of Agriculture)

Continuing with this project, queens tested in 1937 for resistance to disease were placed in the colonies here. Various crosses were made. In all 971 queens of known parentage were produced and shipped to the cooperators on the project. In November sixteen queens were received

and with them the breeding work for 1939 will be carried on. As this Station is concerned only with the production of queens no information is at hand relative to the outcome of the resistance problem. The one point of interest to this Station is that it has become evident that the Laboratory strain of honeybee is more resistant to the attacks of the wax moth larvae than the colonies originating from the mixed strains of northern origin. During the year 1939 crosses will be made of the Laboratory strain and supposed disease resistant strains in an attempt to breed a race that is resistant both to the attacks of the wax moth larvae and brood diseases.

H. B. Parks, A. H. Alex.

Horsemint for Honey and Oil Production

The horsemint project which has been in operation since the beginning of this Station has received during the past year another impulse which may lead to its completion. Two botanists have suddenly become interested in a systematic study of the genera and several chemists interested in the chemical content have started investigations. This has come about very largely from the reduction of a supply of crude mint oil from the Orient. During the present year much material for systematic and analytical work was supplied from this Laboratory.

H. B. Parks, A. H. Alex.

Plant Survey of Texas

The publication of the plant survey of Texas created so much interest that Bulletin 550 had to be reprinted this year. As a direct result of this special surveys were demanded. Much time was given to study of plants valuable for pasturage and during the last half of the year deaths caused by plant poisoning to livestock necessitated a poisonous plant survey of Trans-Pecos Texas.

H. B. Parks, V. L. Cory.

Plants for Tannin

Rumex Hymenosepalus Torr. *Canaigre* has been under experiment at this Station since 1922. The interest was revived by the Bureau of Plant Industry. Plantings were made this year under the supervision of this Bureau. Tubers from West Texas were used in addition to our selection. Although the growth period was restricted by drought in 1938 tubers from our strain were more numerous and much larger than those from the West Texas strain. As yet no information is at hand as to the tannin content.

The Genus *Rhus*. This genus which has been under investigation here since 1924, was also taken up by the Bureau of Plant Industry in a hunt for tan material. Large samples of the leaves from this genus were

collected but no definite information has been received as to the tan content.

H. B. Parks, A. H. Alex.

Miscellaneous

The activities of the S. M. Tracy Herbarium necessitated four trips to College Station during the year and field work connected with it were two long trips and numerous short ones. With the plant collection of 1937 which was deposited with the herbarium late in 1938 and the new collection of 1938 together with material already mounted at this Laboratory there is a total of approximately forty thousand named herbarium specimens. It is estimated that the total number of species represented by mounted specimens now on the shelves is about four thousand two hundred. The total number of plants known to be native to Texas at the present time is about five thousand two hundred.

H. B. Parks.

AGRICULTURAL ENGINEERING

Mechanical Harvesting of Cotton

In testing the efficiency of the Texas Station Cotton Harvester on 28 different strains and varieties of cotton at College Station on September 3, 1938, an average of 94.4 per cent of the cotton on the plants was harvested. The lowest per cent, 87.9, was obtained in harvesting Mebane 96, while the highest, 97.4, was obtained with Gorham's Lone Star.

In comparing the grade of mechanically harvested cotton with hand-picked and hand-snapped cotton for each of these 28 strains, hand-picked cotton averaged middling plus; hand-snapped, strict low middling plus; and machine harvested, low middling plus. There was a difference of two grades between hand-picked and mechanically harvested cotton and one grade between hand-snapped and machine harvested cotton.

At Lubbock in harvesting 9 different strains and varieties of cotton an average of 97.8 per cent of the cotton on the plants was harvested. The lowest per cent, 96, was obtained in harvesting Kubela B-5, while the highest, 98.9, was obtained in harvesting a selection called Macha. When the grades of hand-picked, hand-snapped, and mechanically harvested cotton were compared, it was found the average grade for each of the three methods of harvesting was strict middling.

The average yield of cotton the machine tested ranged from one-half to one bale to the acre. Varietal characteristics appeared to affect the efficiency of the machine more than the yield per acre.

Numerous crosses and selections were again made, both at College Station and at Lubbock, in an effort to develop a more suitable variety of cotton for mechanical harvesting than the more commonly grown varieties.

Snapping qualities of cotton bolls: The study on the snapping qualities of cotton bolls, begun in 1936, was continued this year on all the strains and varieties used in the mechanical harvesting tests. It appears that the pounds pull required to remove bolls pulled in 1938 was slightly less than that required in 1937.

H. P. Smith, D. T. Killough, and D. L. Jones.

Factors of Efficiency in the Distribution and Placement of Cottonseed and Fertilizers

Machine placement and soil disturbance studies: This study was conducted at both College Station and Nacogdoches and is a continuation of studies begun in 1936. The results obtained this year show that when fertilizer is placed 1 and 2 inches under the seed, fewer seedlings are obtained than on the checks with the same soil disturbance. Other placements showed that more seedlings emerged on the fertilized rows than on the unfertilized checks with the same soil disturbance. Higher yields were obtained on all the fertilized rows than on the corresponding checks.

Treatment of cottonseed for planting purposes: This test was conducted at both College Station and Nacogdoches and is a continuation of tests begun in 1936. Fuzzy and acid delinted seed were treated with Ceresan, lime, and sulphur to determine the effects on germination and yields.

Fuzzy seed treated with Ceresan at Nacogdoches and with sulphur at College Station gave better stands than did either the untreated seed or seed treated with lime or sulphur. Delinted seed treated with Ceresan gave better stands at both College Station and Nacogdoches than did the untreated seed or those treated with lime or sulphur.

With fuzzy seed there were no significant differences in the yields for the various treatments at College Station, but slightly higher yields were obtained with the sulphur treatments at Nacogdoches. Sulphur treated delinted seed also gave slightly higher yields at Nacogdoches than did any of the other treatments. At College Station untreated delinted seed gave the highest yield and seed treated with sulphur the lowest.

Width of furrow openers: Better stands of cotton and higher yields were obtained when cottonseed were placed in a narrow furrow made with a narrow shovel furrow opener than when a wide shovel was used.

Effect of press wheels: Fewer seedlings emerged on all tests where press wheels were used, either before or after covering, than where no press wheel was used. Four combinations of press wheels were used in the tests: (1) rubber before covering; (2) rubber before covering and open center steel after covering; (3) open center steel after covering; and (4) narrow wood wheel after covering.

H. P. Smith.

Atmospheric Exposure Tests of Wire and Fencing

This study is in cooperation with the American Society for Testing Materials and is one of eleven tests being conducted in the United States. All the bare or uncoated specimens are badly corroded, and 19 samples of unfabricated wire were returned for tensile strength tests. None of the galvanized zinc-coated specimens are showing any signs of rusting. Some of the specimens, however, show more signs of weathering than others. Weathering is more on the south side of the stays and on the top line wires.

H. P. Smith.

Eradication of Prickly Pear

A survey of the eradication work being done by ranchmen of the Edwards Plateau region during August, 1938, indicated that approximately 20,000 acres were being poisoned with arsenic pentoxide and at least 100,000 acres were being cleared of prickly pear by grubbing. The poison consisted of about three pounds of arsenic pentoxide and one-half to one pint of commercial strength sulphuric acid to one gallon of water. A small amount of Rhodamine B dye was added to give color to the sprayed plants. This solution was sprayed on the pear plants in a fine misty spray with sprayers made of 18-8 stainless steel.

W. H. Dameron and H. P. Smith.

Garlic Drying

A study of garlic diseases and artificial methods of curing garlic to prevent decay is being conducted jointly by the Divisions of Agricultural Engineering and Plant Pathology and Physiology. In drying 2,500 pounds of garlic for a period of 14 hours at 120° F. the average loss in weight was 9.4 per cent. Removing the roots, dirt, and dry husks resulted in an additional loss of 12 per cent. Artificially dried garlic stored in an open shed for a period of 76 days lost on the average 16 per cent of its weight, while garlic dried on wire shelves under a canvas shade lost 10.88 per cent. The loss by decay of the artificially dried garlic while in storage averaged 18.83 per cent and that of the shade dried garlic 5.44 per cent.

A U-shaped blade mounted on a sled was used to loosen the soil around the garlic so that the bulbs could be lifted out by hand, without exposing them to the hot sun, which will scald or blister them. The bulbs can be lifted from the soil by grasping the tops with the hands and placing them in piles to be collected and immediately placed in a shade. Two farmers borrowed this machine and another had a blacksmith fit a U-shaped blade on a cultivator to use in harvesting garlic.

H. P. Smith, G. E. Altstatt, and A. A. Dunlap.

WILDLIFE RESEARCH

(In cooperation with the Bureau of Biological Survey, U. S. D. A.; the State Game, Fish, and Oyster Commission; the School of Agriculture, and the Extension Service, A. and M. College of Texas)

County Wildlife Resources Survey

Walker County: While the Walker County Survey is officially closed, it is planned to continue indefinitely observations on certain ones of the bobwhite quail experimental areas near Huntsville.

A quail census made in the fall of 1937 over 6,213 acres by CCC enrollees of the Huntsville, Texas camp of the National Park Service, under the supervision of Siegler, showed that quail had decreased 31.1 per cent on the census area since 1936. No satisfactory reason can be assigned for this decrease. Further observations and counts should be helpful.

A further quail count made in the Nacogdoches area by Goodrum, assisted by the Soil Conservation Service, threw a good deal of light on quail numbers in that part of eastern Texas. The methods used were developed in course of the Walker County work by the Texas Unit.

Factors that reduce quail numbers, according to Goodrum, are (1) heavy shooting, (2) overgrazing and undergrazing, (3) climax stands of pure pine in wooded areas, and (4) early breaking of land, which reduces favorable winter range.

Indications are that the quailless farms were the ones where pastures and woodlands were closely grazed and clean farming practiced. Where a reasonable amount of well-distributed woody vegetation was present, however, quail usually were abundant. High quail numbers were not necessarily associated with farms in a run-down condition. A reasonable wild-life population was present on some of the farms that have the highest income per acre.

W. P. Taylor, D. W. Lay and P. D. Goodrum.

Kerr County: The Kerr County survey was completed during the year. The county is representative of the highly important ranching district known as the "Texas Hill Country" where deer and wild turkeys are hunted under the hunting lease law system. Some of the results may be summarized briefly as follows:

Heavy grazing by goats is most destructive, reducing plant, bird, and mammal communities to scattered remnants of the varied and abundant wildlife that should be present.

The scarcity of bobwhite quail in Kerr County, about which there is so much local complaint, is closely associated with the amount of grazing. Several tracts were found where quail were relatively abundant. Without exception these areas were lightly grazed or ungrazed. Quail restoration

will not be successful in Kerr County so long as cover and food for the birds are destroyed by overgrazing.

Fur animals and small rodents are scarce throughout Kerr County.

The deer population on better-than-average ranches is estimated to be one to 20 acres. Leases to parties for 5 years or more, with strict limitations on numbers that may be killed each year, are more satisfactory than leases by the year or than day hunting. Wise ranchers restrict hunters to bucks of 8 points or more, and do not permit hunting near watering places.

There are two critical periods for deer: (1) summer, when every cut or scratch is susceptible to screw-worm infection, usually fatal, and (2) winter, when, if the season is severe and long, available deer food is much reduced. The average dressed weight of 100 deer in the Kerrville and Fredericksburg ice houses was 83½ pounds (January 1938), and the circumference of the beam of the horn near the base was found to be directly related to the weight of the deer.

Although many unanswered problems remain, it is obvious that the Texas hunting preserve law, as it is actually working out in Kerr County, is highly satisfactory. Seemingly this law could be far more widely utilized in this State to the decided advantage of all concerned.

W. P. Taylor, D. W. Lay, and T. F. Smith.

Colorado County: Active work on this county-wide survey was initiated by Lehmann and Siegler in February, 1938. Colorado County is in the coastal prairie type, and is representative of a considerable area of ranch, farm, and forested land in the upper coastal prairie.

In the northeastern part of the county 31 coveys of bobwhite quail occupy 12,155 acres of ranch-upland farm territory. Of the 31 coveys, 28 contained 357 quail, or an average of 12.7 birds each. The estimated population of the above acreage is 393 quail, or about one bird to 30.8 acres. Scarcity of protective cover is the most important factor limiting quail increase in this area.

Landowners estimate that grackles (*Cassidix mexicanus prosopidicola*) destroy one-half barrel of rice per acre annually throughout the Colorado County rice belt. The average annual yield of rice is only 12 to 14 barrels per acre. Diligent patrol during the critical period, with the use of frightening devices, is recommended. Poison (rice-strychnine) is effective, but neutral or innocent species of birds may be killed. There are also some legal restrictions that complicate the situation.

White-tailed deer were numerous in Colorado County prior to 1900. They decreased from 1900 to 1922 when it is thought there were but 125 individuals remaining in the entire county. Since that time the efficient protection given them by game warden T. T. Waddell has resulted in steady increase. Over 300 legal bucks were taken last season.

The sale of deer-hunting privileges under the Texas hunting preserve law began in Colorado County in 1930. In 1937-38 22 landowners earned \$3,000 through this means. Of 19 owners interviewed, 3 leased by the day at \$3.50 per man; 3 sold seasonal rights at \$15 to \$25 per man; 13 leased to clubs. The largest shooting preserve was 11,000 acres, the smallest 170 acres. The smallest amount received from the sale of hunting rights was \$25, the largest \$250. On the average, leasers received \$133 each.

Deer do damage to sweet potatoes, peas, peanuts, watermelons, cantaloupes, hegari, and maize. Most of the damage is done to small farmers whose places adjoin large ranchers. The use of repellents to keep deer out of cultivated fields shows some promise. Sulphur dusted on plants at the borders of the field has given partial relief, and burlap bags soaked in carbolineum and hung on fences gave complete relief in specific instances.

V. W. Lehmann and H. R. Siegler.

Harris County: Work was begun in this county about June 10, 1938. Field work in one of the largest counties (1,058,560 acres) in eastern or central Texas, having within its borders the largest city in the State (Houston), will afford an opportunity to determine wildlife possibilities close to a large center of population.

It has already been found that an excellent quail stock exists throughout much of the county. It is intended to test out the effect on this population of fencing headquarters areas for coveys of quail in winter. Fifteen farms have been closely examined, in company with county agent Dan Clinton, and 6 selected in different ecologic types in various parts of the county, to serve as demonstration areas. On each it is planned, where practicable, to fence in 3 quarter-acre areas against livestock. One area on each farm will be fenced, plowed, and planted (with suitable quail feed, such as Schrock, red top, Sudan grass or other crop); a second will be fenced and merely plowed, to ascertain what native plants will respond; and the third will be fenced, and left as it is, to find out whether suitable wildlife food plants will grow merely under protection from grazing, with no further treatment.

W. P. Taylor, T. F. Smith, and B. E. Ludeman.

Quail Management in Texas

Genetic experiment: An experiment, designed to test the effects on sex ratio, vigor, color, and general characteristics of hybridizing the Texas bobwhite (*Colinus virginianus texanus*) and the Virginia bobwhite (*C. v. virginianus*), has been continued through the year. Only 7 birds were raised last season, 6 females, 1 male. It is hoped this season to raise a considerable number of the birds so as to make some F_2 matings. Nineteen of 26 mated pairs were laying in June 1938 and a considerable number of eggs (163) were already in process of incubation on the 30th of that

month. Considerable difficulty is experienced in keeping the young quail alive. They survive all right during the daytime, but some are likely to be found dead under the brooder overnight.

Professor D. H. Reid, head, department of poultry husbandry, has now taken over this project.

D. H. Reid and H. Hahn.

Field experiment, Walker County: This project was completed February 24, 1938. A report is being prepared. Results seem to indicate that the introduction of Mexican quail (*Colinus virginianus texanus*) into a population of Virginia quail (*C. v. virginianus*) does not unbalance the sex ratio during the first two generations.

V. W. Lehmann and H. R. Siegler.

Winter food of bobwhite, scaled, and Gambel quail: Analysis of 1,000 stomachs of bobwhites collected in December and January 1934-35 revealed that the twelve most important winter foods of bobwhites in Texas are:

1. Doveweed, Croton (especially *C. capitatus*, *C. monanthogynus*, and *C. punctatus*).
2. Panic grass, Panicum (especially *P. texanum*, *P. fuscum*, and *P. capillare*).
3. Johnson grass (*S. halepense*).
4. Oak, Quercus (especially *Q. nigra*, *Q. virginiana*, *Q. stellata*, and *Q. rubra*).
5. Paspalum, Paspalum (especially *P. stramineum*).
6. Ragweed, Ambrosia (especially *A. psilostachya*, *A. artemisifolia*, *A. aptera*, and *A. trifida*).
7. Mesquite, Prosopis (chiefly *P. glandulosa*).
8. Sunflower, Helianthus (especially *H. annuus*).
9. Snow-on-the-mountain, Dichrophyllum (*D. bicolor*, and *D. marginatum*).
10. Partridge pea, Chamaecrista (especially *C. procumbens* and *C. fasciculata*).
11. Gum elastic, Bumelia (especially *B. lanuginosa* and *B. angustifolia*).
12. Skupk daisy, Ximenesia (*X. encelioides*).

In the winter, Texas quail apparently consume more Croton seed than the seeds of all trees and shrubs combined.

V. W. Lehmann.

Quail management in the coastal plains and prairie regions of Texas: Five out of seven artificially created covey territories (consisting of one-half to one-acre fenced plots planted to sorghum and with brush piles in each corner) attracted and held coveys of bobwhites throughout the winter of 1937, even though some of the territories were built on flat open prairie fully two miles from spots where quail had been known to winter before. The apparent success of these fenced areas, constructed on the R. B. Wallace and R. H. Hancock properties in Wharton County, suggests the

possibility of substantial quail increase wherever desired in the millions of acres of coastal prairie territory.

This, and other observations and experiments, have led to the development of the covey "headquarters" concept, which appears to be a step in advance of earlier generalized ideas of quail cover. A small amount of cover, properly placed, may be just as effective in holding a covey of quail as a much larger amount. Manipulating the "headquarters" cover seemingly offers a further promising possibility of controlling the distribution of quail, and even increasing the numbers of quail on a given area.

V. W. Lehmann.

Ecological Wildlife Relationships

Successive censuses on nearly 4,000 acres and other counts on an area of more than 5,000 acres have demonstrated beyond any question that quail are rather scarce during the first 4 years after timber cutting, averaging only about one covey to 140 acres. They are most abundant during the fifth to the ninth years after cutting, when they average one covey to 76 acres. From the tenth to the fifteenth year there is one covey to each 95 acres, and after the fifteenth year they soon drop down to one covey to 500 acres. In no instance was predation found to be a limiting factor. Blue jays help make acorns available to quail; pocket gophers and hogs assist quail by disturbing the soil surface, thereby increasing the growth of quail food. There is a distinct succession of vegetation following cutting and the competent game manager can determine by examining the plants the approximate time since lumbering operations. Recommendations for quail management in cut-over shortleaf-loblolly pine hardwood type include plowing and brush clearing in spots and along trams, protection from heavy grazing and from over-shooting, little or no restocking of quail (since an adequate foundation stock usually is present), little or no control of predators, some burning of slash under carefully controlled conditions, and the optional planting of food patches.

D. W. Lay.

Life History and Ecology of the Gray and Fox Squirrels in Eastern Texas

The gray squirrel is one of the most important game species in eastern Texas. The species is becoming scarcer each year. Methods of counting squirrels have been perfected, the time-area count being the most satisfactory. Gray squirrels prefer the hammocks or low sandy loam ridges along the flood plains. The species fluctuates considerably in numbers from year to year. There was a 13.8 per cent drop between 1936 and 1937. No evidence of squirrel migrations in eastern Texas has been found. There is, however, a shift in spring and fall, depending on food conditions. A density of slightly more than one squirrel per acre may be expected in better-than-average habitat protected from shooting. Hunting pressure

reduces the number, as observed, to one-third this figure. The cruising radius of the gray squirrel is about 200 yards. There are two breeding periods in eastern Texas, a winter period, which reaches its peak in the latter part of January, and a summer period, which reaches its climax in August. Young squirrels remain for surprisingly long periods with the family group. This unfortunate habit facilitates their destruction. Unrestricted timber cutting, grazing, and drainage tend to reduce the number of gray squirrels. Low temperature and high wind are detrimental to them. Pin oak acorns constituted 59 per cent of the food of 87 gray squirrels. A great variety of other foods, including insects, are eaten. Manipulation of habitat should improve conditions for squirrels. Suggested measures include cutting to release suppressed mast trees, and creation of ponds in bottomlands. The Texas squirrel law provides an open season during the breeding season of the animals in eastern Texas and should be changed. The bag limit also, should be cut in half.

P. D. Goodrum.

The Attwater Prairie Chicken

The extirpation of the Heath Hen in the New England states and of the Greater Prairie Chicken in Texas have lent special emphasis to the desperate need for conservation of the Attwater prairie chicken. All the principal details of the distribution, abundance, and life history of the prairie chicken have been determined. For 12 years the annual crop of young chickens has been found to be inversely proportional to the amount of rainfall in May. If and when an open season again is allowed, it should be in November. The annual kill, if ever again justified, should be based on counts made in March, July, and December. No open season should ever be allowed when the May rainfall is excessive.

Details of the study of the Attwater prairie chicken follow:

The "Rope Count," a census method that is over 95% accurate when properly used, has been developed and tested by use over approximately 45,000 acres of chicken range.

A prairie chicken inventory, based on data obtained by censusing of 31,033 acres of territory by the rope counting method was begun in June 1937, and every occupied colony in the State was completely inventoried by September 1937.

The former range of the Attwater Prairie Chicken in Texas was determined at approximately 6,000,000 acres; former numbers were probably well over 1,000,000 birds.

The occupied range of Attwater Prairie Chickens in Texas in 1937 was only about 457,135 acres and the population was 8,711 birds, or less. It was estimated that 4,242 chickens, or almost 50 per cent of all the remaining birds, were on two ranches in Refugio County.

Habitat requirements of the Attwater Prairie Chicken, it was found, were best satisfied in native long grass pastures that were moderately grazed. Limiting factors of importance were found to be (1) general pasture burning during the nesting season, (2) heavy grazing with the attendant spread of brush onto what was once open prairie, (3) agriculture, especially rice farming, (4) excessive or persistent rainfall during the breeding season, (5) over-shooting, (6) drainage enterprises, and, (7) oil development. Predators, except wild house cats and wild dogs, were found to be of negligible importance as limiting factors in areas where satisfactory food and cover conditions prevailed. Under unmanaged conditions prairie chickens are cyclic, the abundance or scarcity of young birds is seemingly determined by the amount of precipitation during May, the peak of the nesting season.

V. W. Lehmann.

Present Status and Needs of Threatened Species in Texas

Peccary: With the cooperation of William J. Tucker and nine game wardens, it was determined that the range of this interesting native wild hog has markedly decreased. The animals are of appreciable value for their hides, for food, and as an object of sport. Former President Theodore Roosevelt once made a trip all the way to Texas to hunt them. At present they are not protected under any general Texas law, but they are in great need of such protection.

Prong-horned Antelope: This animal is being more and more restricted in geographical range in Texas, although, fortunately, it is increasing somewhat in limited areas west of the Pecos River. While Bailey, in 1905, recorded the prong-horn from 65 Texas counties, Nelson, in 1924, could get definite reports from only 46 counties (19 less than Bailey's), and Taylor's check-up (1937) shows antelope in but 31 counties (15 less than Nelson's, 34 less than Bailey's). The total number of antelope, however, has probably more than doubled in the last 15 years, and may total between 4,000 and 5,000.

Texas Bighorned Sheep: This species, according to the best information available, is down to approximately 300 individuals altogether within Texas. It is gone from the Glass Mountains, the Chisos Mountains, and many others, and is found on some of the ranges in Culberson and neighboring counties only. There is so much unsupported rumor concerning the status and occurrence of the Texas Bighorn that it will be necessary to recheck every mountain range where the species is reported, or suspected, to occur. Inimical factors should be determined, and definite efforts made to bring the Bighorn back. The ranges of Trans-Pecos Texas should be able to support many of these animals.

W. P. Taylor and W. B. Davis.

Mammals of Texas

A study of the pocket gophers of Brazos County revealed the presence there of a new subspecies that has been named *Geomys breviceps brazensis* Davis. In connection with this study, it was learned that pocket gophers in that region occur only in soils where the topsoil consists of sand or sandy loam 4 inches or more in depth. Also, it was found that the average number of pocket gophers per acre in that vicinity is near 1.5; a population of 7 per acre is extremely high.

Pocket gophers usually are considered as pests, but their existence in many instances can be justified. Fossorial in habit, they excavate numerous underground burrows that loosen the soil so that it absorbs more water; also, the soil is thereby better aerated. Pocket gophers bring up an enormous amount of earth from the lower strata, into which the chemical elements of the soil so needed by plants have leached, and deposit it on the surface. In one section of the College Farm at College Station the amount of earth brought to the surface by these rodents has been calculated to be near one acre-inch per year. Considerable humus is incorporated with the soil by the "plowing" activities of pocket gophers, thus, enriching the top soil.

Except for game species, fur bearers, predators, and a few of the more common rodents, the mammal group is little known by the average person in Texas. In all, 211 species and subspecies of mammals are known to occur, or to have occurred until recently, in Texas and its coastal waters. These are divided among nine Orders as follows: Marsupialia (opossums), 3; Insectivora (shrews and moles), 7; Chiroptera (bats), 19; Carnivora (flesh-eaters), 46; Rodentia (rodents), 111; Lagomorpha (rabbits), 13; Artiodactyla (big game), 9; Xenarthra (armadillo), 1; Cetacea (whales and porpoises), 2. A check-list of the mammals of Texas is being prepared.

W. B. Davis.

FEED CONTROL SERVICE

Inspection

The usual inspection of feeding stuffs has been continued during the past year and eight inspectors have visited feed manufacturers, feed dealers, and a considerable number of consumers in order to secure official samples for analysis and to detect possible violations of the provisions of the Texas feed law. Each inspector is required to file at the office each week an itinerary which is subject to revision if considered advisable. In addition he is required to submit a daily report of his activities. During the period covered by this report the inspectors have traveled 109,000 miles in the performance of their official duties and visited 29,905 firms in 4,536 towns and cities. Several trips were made from the office for the purpose of carrying on special investigations.

Computed from the sale of feed inspection tags there were 1,542,833 tons of feed sold in the State during the fiscal year ended August 31, 1938.

This amount represents only the tonnage of feeding stuffs regulated by the Texas feed law, and is based on the assumption that all the tags sold during this period were used for feeds sold during that period. The 1937-38 sale of feeding stuffs in Texas is the largest on record and has steadily increased during each of the past six years with one exception. Cooperation with the Food and Drug Administration of the U. S. Department of Agriculture has been continued and thus control exercised over interstate shipments of feed as further protection to Texas purchasers.

Samples

During the fiscal year the inspectors secured 3,525 official samples of feed, which were subjected to chemical analysis and microscopic examination by the Division of Chemistry. In addition to these, there were analyzed a few registration and special samples, making a total of 3,563 samples analyzed during this period. In addition, twenty-four samples of vitamin D carriers were assayed for antirachitic potency, twenty-three samples of cottonseed cake were tested for hardness, and seven samples of cottonseed hulls were analyzed. Three hundred and three determinations of salt and one hundred and nine determinations of carbonate of lime in mixed feeds were also made.

Reports

The results of inspections and analyses are reported to the manufacturer, dealer, and consumer as soon as practicable after the results are available. When a shipment appears to be adulterated or misbranded, the dealer is notified and advised to remove it from sale until the matter has been satisfactorily adjusted.

Shipments Withdrawn from Sale

During the year covered by this report dealers were advised to remove from sale 472 shipments of feed, manufactured by 336 different firms, totaling 1,692 tons. These shipments were withdrawn from sale because they did not meet the requirements of the law. Untagged shipments were properly labeled with tags furnished by the manufacturers; improperly labeled shipments were relabeled with official tags properly printed, or with tags showing guaranties that could be maintained, and in still other cases shipments were returned to the manufacturer. The sales of goods below guaranties were adjusted, in practically all instances, by manufacturers paying refunds to dealers and consumers when the deficiencies were sufficient to warrant such action. In all cases where refunds were made to dealers, the dealers were advised to prorate the same to their customers, in so far as possible, so that the ultimate consumer would receive its benefit.

Violations

During the year seven complaints were filed with County Attorneys against manufacturers violating certain provisions of the Texas feed law. Each of these cases was settled by payment of fine and docket costs. Twenty-eight firms were cited for hearings to be held in the office of this Division for the purpose of presenting evidence to show cause why they should not be prosecuted for violating the law. Eighteen of these firms sent representatives to the hearings and ten answered the citations by letters. Upon presentation of the evidence such action was taken as seemed advisable. Six hundred and four minor complaints were adjusted through correspondence, together with the assistance of the inspectors. These complaints consisted of untagged shipments of feed; improperly labeled shipments; incorrectly printed tags attached to the packages of feed; short-weights; deficiency in crude protein; excess of crude fiber, and other minor irregularities.

During the year there were nine Federal cases developed against manufacturers shipping feed into this State in violation of the Food and Drugs Act of 1906. The necessary evidence in each case was transmitted to Federal authorities for legal action. These cases were then referred to United States Attorneys having jurisdiction and prosecution of violators recommended. Two of the cases have terminated by payment of fines and costs. Seven cases are now pending.

Hardness of Cottonseed Cake

The determination of the hardness of cottonseed cake has been continued during the past year. Twenty-three samples representing the output of twenty-two oil mills were tested for hardness and the crushing strength varied from below twenty pounds, soft, to 2,845 pounds, very hard. Most of the samples examined, however, were classified as medium hard.

F. D. Fuller, James Sullivan.

PUBLICATIONS

The Division of Publications edited and received for distribution eleven bulletins, one circular, and the Director's annual report. Notice was received of publication in various scientific journals of 31 technical papers prepared by members of the Station staff. Members of the Station staff reported 107 popular papers published in the various current journals and newspapers. There were 90 Progress Reports prepared in this division and mimeographed for dispatch to the press and various agricultural workers including the Extension Service workers and the Smith-Hughes vocational teaching staff. Most of these Progress Reports were also read over the Texas Quality Network through the College broadcasting station, WTAW.

The Annual Abstract Circular, No. 81, was prepared in this division and carries abstracts of all publications issued in 1937, including bulletins 539-557, inclusive, circulars 79 and 80, as well as the Director's 49th Annual Report for the year 1936, and the report of the soil survey of Cass County, Texas, February, 1937. The circular carries abstracts of 39 scientific articles and citation of 77 popular articles appearing principally in Texas publications during the calendar year 1937. A list of available publications including available mimeographed Progress Reports is included in this circular which was published in an edition of 75,000 copies and sent to all names on the mailing list.

A total of 287,781 publications were distributed during the year, leaving on hand in the mailing room 832,287 copies available for free distribution.

Following is a list of the technical papers and the bulletins and circulars published from September 1, 1937, to August 31, 1938:

Technical Papers

385. Notes on Leafhoppers Found on Cotton; R. K. Fletcher. *Journal of Economic Entomology*, Vol. 30, No. 6, pp. 863-864, December, 1937.
386. Sorghum Web Worm Studies in Texas; H. J. Reinhard. *Journal of Economic Entomology*, Vol. 30, No. 6, pp. 869-872, December, 1937.
387. A Modified Root Tip Smear Technic; William L. Brown. *Stain Technology*, Vol. 12, No. 4, pp. 137-138, October, 1937.
401. Facing the Tax Problem; C. S. Wilkins. *Southwestern Social Science Quarterly*, Vol. 18, No. 3, pp. 284-285, December, 1937.
402. Patronage Dividend Policies of Cooperative Cotton Gins of Texas; W. E. Paulson and R. T. Baggett. *Journal of Farm Economics*, Vol. 19, No. 4, pp. 878-885, November, 1937.
405. Length of Life: A Study of the Life Table, by Louis I. Dublin and Alfred J. Lotka; C. Horace Hamilton. *Rural Sociology*, Vol. 2, No. 4, p. 505, December, 1937.
407. Evaluation of Some Soil Fungicides by Laboratory Tests with *Phymatotrichum Omnivorum*; Walter N. Ezekiel. *Journal of Agricultural Research*, Vol. 56, No. 8, pp. 553-578, April, 1938.
408. Tests with Pentachlorethane, Tetrachlorethane, and Xylol to Determine Their Efficiency in Eradication of *Phymatotrichum* Root Rot; Walter N. Ezekiel. *Journal of Agricultural Research*, Vol. 56, No. 8, pp. 579-593, April, 1938.
409. Cross Sterility in Hybrid Plum Varieties; Walter S. Flory. *Proceedings of the American Society for Horticultural Science*, pp. 43-46, 1938.

416. Four New Nearctic Species of *Fabriciella*, (Tachinidae, Diptera); H. J. Reinhard, *Canadian Entomologist*, Vol. 70, No. 1, pp. 8-11, January, 1938.
417. Breeding Strawberries for Texas; E. Mortensen and S. H. Yarnell. *Proceedings of the American Society for Horticultural Science*, 1938, pp. 57-59, 1938.
420. Cytology of *Phymatotrichum* Root Rot of Cotton Seedlings Grown in Pure Culture; G. M. Watkins. *American Journal of Botany*, Vol. 25, No. 2, pp. 118-124, 1938.
422. Studies on the Cause of Immunity of Monocotyledonous Plants from *Phymatotrichum* Root Rot; Walter N. Ezekiel and J. F. Fudge. *Journal of Agricultural Research*, Vol. 56, No. 10, pp. 773-786, May, 1938.
423. Breeding Tomatoes to Extend the Fruiting Season; S. H. Yarnell and Leslie R. Hawthorn. *Proceedings of the American Society for Horticultural Science*, 1938, pp. 585-589, 1938.
424. Cytology of *Phymatotrichum* Root Rot of Field-Grown Cotton; G. M. Watkins. *Phytopathology*, Vol. 28, No. 3, pp. 195-202, March, 1938.
429. Practical Applications of Productive Energy Values to Problems Concerning Feeds and Feeding; G. S. Fraps. *Proceedings of the American Society of Animal Production*, pp. 20-26, November, 1937.
432. Plant Disease Survey in Southwest Texas; P. A. Young, G. E. Altstatt, and A. L. Harrison. *Plant Disease Reporter*, Vol. 22, No. 1, pp. 6-12, January 15, 1938.
433. Adaptability Studies with Date Palms in Southwest Texas; J. F. Wood and E. Mortensen. *Proceedings, American Society for Horticultural Science*, Vol. 35, pp. 231-234, 1937.
434. Some Ecological Factors Affecting Vegetable Varieties in Southwest Texas; Leslie R. Hawthorn. *Proceedings, American Society for Horticultural Science*, Vol. 35, pp. 690-692, 1937.
435. The Reclamation of Decadent Citrus Trees; W. H. Friend. *Proceedings of the American Society for Horticultural Science*, Vol. 35, pp. 143-146, 1937.
436. The Probable Effect of Peduncle Abscission on the Incidence 'die-back' of Roses; J. C. Ratsek. *Proceedings of the American Society for Horticultural Science*, 1937.
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466. Texas Farm Tenure Activities; C. Horace Hamilton. The Journal of Land and Public Utility Economics, Vol. 14, No. 3, pp. 330-333, August, 1938.
467. The Effect on Tenderness of Meat, of Differences in Time of Cooking Produced by Oven Temperatures and by Other Means; Sylvia Cover. Journal of Home Economics, Vol. 30, No. 8, p. 586, 1938.
470. The Origin of Maize; P. C. Mangelsdorf and R. G. Reeves. Proceedings of the National Academy of Sciences, Vol. 24, No. 8, pp. 303-312, August, 1938.

STATION PUBLICATIONS

Bulletin	Title	Author	No. Pages	No. Copies
556	Strawberry Varieties in Southwest Texas.	E. Mortensen.	32	8,000
557	Losses of Vitamin A and Carotene from Feeds During Storage.	G. S. Fraps and A. R. Kemmerer.	28	8,000
558	Blackberry and Dewberry Varieties in East Texas.	H. F. Morris.	30	7,000
559	The Sorghum Webworm (<i>Cetana sorghivella</i> Riley).	H. J. Reinhard.	35	6,000
560	The Relation of the Spectro Vitamin A and Carotene Content of Butter to Its Vitamin A Potency Measured by Biological Methods.	G. S. Fraps and A. R. Kemmerer.	21	6,000
561	Cultural Experiments with Yellow Bermuda Onions Under Irrigation.	Leslie R. Hawthorn.	30	6,000
562	Maturity Studies of Marsh Seedless Grapefruit in the Lower Rio Grande Valley.	J. F. Wood and Harold M. Reed.	39	6,000
563	Effect of Calcium Supplements on Gains of Lambs Fed Sorghum Fodder or Sorghum Silage as the Roughage Portion of the Fattening Ration.	J. M. Jones and W. L. Stangel.	47	6,000
564	Steer Fattening Investigations.	J. H. Jones, R. A. Hall, J. M. Jones, and W. H. Black.	51	6,000
565	Commercial Fertilizers in 1937-38.	G. S. Fraps, T. L. Ogier, and S. E. Asbury.	47	8,000
566	Commercial Feeding Stuffs, September 1, 1937, to August 31, 1938.	F. D. Fuller and James Sullivan.	195	9,000
Circular 81	Abstracts of Bulletins 539-557, Circulars 79-80, and Other Publications During 1937.	A. D. Jackson.	41	75,000
	Forty-ninth Annual Report.	A. B. Conner.	321	6,000

A. D. Jackson.

SUBSTATION NO. 1, BEEVILLE

Substation No. 1, located in Bee County, five miles east of Beeville, serves the interior Black Prairie Region, a large area of dark colored, fertile soils lying in South Texas. Goliad and Victoria soil types predominate in this region. An average annual rainfall of 31 inches is fairly well distributed throughout the year, with more of it coming in the winter and spring months. Mild temperatures, with few frosts, prevail, giving an average growing season of 288 days. All these factors combine to make this region admirably adapted to diversified farming with livestock as a base. The critical period for plant growth in this area is the hot and dry season coming in July, August, and September. Therefore it seems advisable to turn more attention to the growing of crops during the winter and spring months when moisture is usually sufficient and temperatures are more favorable to plant growth. With these facts in mind the station is turning more and more attention to finding and developing crops suitable for growing in this period.

The chief concern of this station is the development of a profitable land utilization and soil conservation program adapted to this region. Its activities consist chiefly of testing, developing, growing and curing of feed crops and grasses, and their utilization through beef cattle; and the testing, developing, and growing of profitable cash crops with which to complete a balanced system of agriculture. Some attention is given to testing trees and ornamentals for use in landscaping.

Feed Crops

Climatic conditions for 1938 were rather unfavorable at times for crop production. Considering the total moisture deficiency of 9.56 inches and the late spring, fair yields were secured from most crops.

Corn: Corn gave better than an average yield. It suffered some from damage by frost and cold winds on April 9 and 10 but soon recovered. Good rains during the filling period aided in an increased yield. Drouth during the late season caused late planted corn to ripen prematurely and reduced the weight of earlier planted corn to some extent.

Fifty-four varieties and selections were included in the corn variety test. The highest yield came from a Yellow Surcropper, X inbred Thomas cross with 34.7 bushels per acre. Sixteen crosses containing Surcropper blood were close to the top in production this season. Earliness was a factor in production because of the drouth in the late maturing season. Twenty-four Golden Thomas selections from the ear to row breeding block made good showings in comparison with old line strains. These strains varied from 23.2 to 28.1 bushels per acre. The highest yield from old line varieties, of 28.1 bushels per acre, came from White Thomas. In the period of years summary Golden Thomas and White Thomas continue to show best yields of good sound corn.

Golden Thomas breeding work was continued. This corn, which was bred from White Thomas, is rapidly becoming the most popular corn in the Beeville area. Several hundred bushels of State Certified seed were produced and are being distributed by farmers in this area. Fifteen acres of State Registered seed were grown by the Station to supply certified breeders with pure seed stock. 72 strains were grown in the ear-to-row blocks, 24 of which will be grown in the 1939 variety test for comparison. Each year five of the best of these are selected for planting in the registered seed blocks.

Grain Sorghums: Early planted grain sorghums gave excellent yields from the first cuttings. Drouthy condition at harvest time prevented good tillering from the stubble and reduced second crop yields. August rains matured the thin stand and in some instances gave fair second cuttings of forage. Very poor grain yields were obtained from this growth.

Twenty-seven varieties were included in the grain sorghum variety test. The highest yield of seed from the first cuttings came from Red kafir X Hegari with 54.9 bushels per acre. Schrock kafir came second with 44.4 bushels. It was followed in turn by Red kafir, Ajax, Chiltex, Milo X Kafir, Texas Blackhul Kafir, and Sumac. The highest forage yield came from African Millet, with 5.1 tons forage per acre. Atlas sorgo was second with 4.7 tons. It was followed in turn by Sumac, Spur feterita, Orange sorgo and Grohoma. None of the varieties produced much grain on the second crop. Grohoma, Spur feterita and African Millet gave the highest yields of forage from this second cutting. All the milos and Leoto sorgo produced practically no second crop. When all characteristics are considered Texas blackhul kafir for early planting and hegari for late planting continue to give best results for grain production. Leoto sorgo, Atlas sorgo, African millet, Schrock and Sumac are recommended for ensilage crops. These are outstanding in their resistance to bird damage.

In a grain sorghum date of planting test Texas Blackhul Kafir gave the highest grain yield when planted April 16 and the highest forage yield on the May 5 planting. Hegari gave highest grain yields from March 26 planting and highest forage yield from May 5 planting. Milo gave highest grain yields from April 16 planting and highest forage yields from March 26 planting. The May 5 planting of Milo gave no grain yields. These results are different from the period of years average, which gives best planting date for kafir around March 20 and for hegari about April 1. Milo should be planted about the same time as kafir.

Small Grains: Forty-four wheat and forty-four oat crosses and selections were planted in a small grain nursery to test their resistance to the rusts. Poor yields were secured on all plantings because of the drouth in April. However, some strains showed remarkable ability to resist both leaf and stem rust. Gradual progress is being made toward the development of a small grain that can be profitably grown in this coastal section. Increased plantings of Victoria oats showed complete resistance to leaf

rust, but were almost completely ruined by stem rust following the early May rains. Very little seed was matured. The best yields were secured from late planted oats in rows. Hubam clover interplanted with the oats made fair yields. This practice of interplanting gives some promise of good results for grazing.

Grasses: Dallis and Rhodes grasses, planted in 1935, continue to grow and thicken the sod on the ground. These grasses have not been grazed. Sudan grass continues to be the most popular cultivated grass for this section.

Cash Crops

Cotton: An April frost and severe north wind almost killed cotton that was up at that time. The plants that survived were delayed in growth fully one month. This delay combined with late drouth caused a reduced cotton yield for the year. Thirty-six varieties were included in the cotton variety test. Mebane 804-50 gave the highest yield with 1,057 pounds of seed cotton per acre. It was followed closely by Northern Star with 1,048 pounds. Watson came third with 1,041 pounds. These were followed in the order named by Chapman Ranch Mebane, Lone Star No. 5, Startex 619, Cluster, Qualla, Cliett and Mebane. The early maturing varieties failed to make the showing that has been given them for the past three years. In an eight-year average Mebane 804-50 leads the field in an average dollar per acre production.

Mebane 804-50 and Lankart, two varieties representing different types of cotton, were included in a date of planting test. Beginning on February 20 these varieties were planted at 10-day intervals, up to April 1. The highest yields for each variety came from the April 1 planting. The second highest came from March 1 planting. The others followed in turn with February 20, March 10 and March 20. These results are out of line with a period of years summary which gives the highest yield from the earliest planting, followed in turn by successive later plantings. These 1938 results are probably due to the frost and wind injury on April 9. Older cotton was damaged more severely.

Breeding work with cotton, started in previous years, was continued. Hybrid strains of Mebane 804-50 X Lankart were increased and tested. New crosses were made. To date no outstanding results have been secured.

Broom Corn: Weather was unfavorable for the breeding work with Texas Scarborough broom corn. Sufficient State Registered seed were produced to supply growers of State Certified seed with foundation stock. Pure line strains were grown in head to row plats. Seed were bagged from these plats for planting in 1939. Unfavorable weather prevented testing of these strains and they will all be carried into 1939. Texas Scarborough Dwarf variety is being enthusiastically received throughout this broom corn area, by growers and buyers alike.

In broom corn spike Inheritance test, seed from good heads, center stem heads and spike heads were planted in alternate rows. As in previous years no greater per cent of spiked heads were secured from seed coming from spiked heads than from seed coming from good heads. These data continue to indicate that spiking in broom corn is not caused primarily by inheritance but is due largely to environment.

Flax: A fourth test in growing flax as a winter crop was successfully completed. Eleven varieties were grown in the nursery rows. Fair yields were secured from the more promising varieties. An average of four years gives about 16 bushels per acre from the better varieties. These nursery results indicate that flax can be successfully grown as a winter crop in this area. Through the assistance of some processors of flax seed 80 bushels of seed were distributed to cooperator growers to be planted in 5-acre blocks for a more extensive trial. In spite of unfavorable weather, yields from these blocks ranged from 5 to 12 bushels per acre. Little differences in yields were apparent from different soil types. Some difficulty was had in combine harvesting because of the uneven maturity of the crop. Considerable increase was made in the test plantings on the station in the fall. Commercial plantings throughout this area have reached several thousand acres. Apparently flax is becoming established as a profitable winter grown cash crop for South Texas.

Dried Citrus Peel and Pulp in Rations of Fattening Beef Cattle

This test covered a 140-day fattening period for yearling steers during the 1937-38 feeding season. The results indicated that dried citrus peel and pulp can safely replace as much as 45 per cent of the ground ear corn, shucks included, when other ingredients consist of cottonseed meal, silage, and cottonseed hulls, and that when so fed has an energy value equal to or slightly greater than that of ground ear corn. When the citrus feed was fed to replace ground ear corn, 25% citrus feed produced greater gain and slightly higher finish than 45%. The steers receiving the dried citrus by-product made slightly greater gain, had a higher finish, and showed sleeker coats of hair than the check group fed ground ear corn. The citrus feed was more laxative than the corn and was not particularly palatable in the beginning, but later was readily consumed.

J. M. Jones, R. A. Hall, J. H. Jones, E. M. Neal.

Ground Rice Hulls in Rations of Fattening Beef Cattle

In this single trial, finely ground rice hulls were fed in limited amount, 3.21 pounds per head daily, in comparison to an equal amount of cottonseed hulls, to 620-pound Hereford yearling steers which received in addition 12 pounds of ground ear corn, 2.8 pounds cottonseed meal, and 11.5 pounds of hegari silage. With cottonseed hulls at a calculated value of 17 therms per 100 pounds, rice hulls in this test showed a value of 4.7 therms.

Despite the slight positive productive value, the results in general indicated that rice hulls should not be used in cattle fattening rations, but if sparingly fed, they may possibly be used in maintenance rations largely because of a bulk value.

J. M. Jones, R. A. Hall, J. H. Jones, E. M. Neal.

Self Feeding Concentrates to Yearling Steers on Sudan Grazing

Gains during the 1938 grazing season made by 458-pound, thin but good quality yearling steers on (1) sudan grass grazing alone and when supplemented with (2) 43% protein cottonseed cake to a second group, and (3) a mixture of 60 per cent ground ear corn, 30 per cent cottonseed and 10 per cent cottonseed meal to a third group, each self fed after being hand fed in limited amounts during the first 10 days on sudan, were compared during a 70-day grazing period.

The check group, receiving grazing alone, made an average gain of 2.43 pounds per head daily. The group self-fed cottonseed cake consumed an average of 11 pounds of this feed per head daily and made an average daily gain of 3.2 pounds, as compared with an average daily consumption per head of 15.3 pounds of the corn-cottonseed-cottonseed meal mixture, which made an average daily gain of 3.5 pounds during the period on grass.

Following the grazing period, the steers were full fed in dry lot. The check group, which did not receive a concentrate supplement during the grazing period, was fed 139 days in dry lot while the two groups that had been fed the concentrate supplement finished in dry lot in 100 days. In attaining a comparable finish, the check group which had been fed no concentrate while on grass, gained approximately 50 pounds more per head, gained more rapidly, and made a lower costing gain. The feeding of supplementary concentrates during the sudan grazing period assures the operator that less time will be required for finishing in dry lot. This test indicated, however, that the average costs of gain will be greater with steers fed concentrates while on grazing than when a supplementary concentrate is not fed.

The steers which received the mixed concentrate while on grass maintained only a slight advantage in gain over those which had received cottonseed cake at the end of the 100-day dry lot finishing period. There was no appreciable difference in market values.

It is difficult to evaluate the practice of feeding concentrates with grazing as compared to grazing only, but any gain resulting from such feeding is produced at high cost. The steers which were fed on grazing had much more finish at the end of the grazing period; however, it is doubtful if this additional finish could have been marketed profitably at the end of the grazing period. Unless the steers are placed directly into dry lot for finishing, it appears that feeding under this method on sudan

grass has little chance to be profitable. It is entirely possible that medium fleshy steers can be finished by self feeding concentrates on sudan grazing, but this point could not be determined in this test due to the fact that the cattle carried little flesh at the beginning of the grazing period; furthermore, the grazing period was limited to 70 days on account of limited rainfall.

J. H. Jones, R. A. Hall, E. M. Neal, J. M. Jones.

Fruit Trees and Ornamentals

All citrus trees came through the 1937-38 season with no cold injury. All varieties bloomed heavily and set a fair crop. Much of it was thrown off during the early summer drouth. However, sufficient fruit remained on Meyer lemon and Satsumas for a fair crop. Even with two irrigations the trees suffered from lack of moisture. The fruit was small and matured rather late. It was of excellent flavor.

Chinese Tallow, Hackberry, Huisache, and Mesquite trees continue as the leading shade trees for this area. Tamarix, California and Amur River Privets, and Senisa, continue to be used largely for hedge and basal plantings. Other native shrubs being used in landscaping are Agarita and Guajilla.

R. A. Hall.

SUBSTATION NO. 2, TYLER

Substation No. 2 is located ten miles northwest of Tyler and five miles southeast of Lindale, Smith County, on Highway No. 69; latitude 32 degrees 28 minutes north and longitude 95 degrees 21 minutes west; elevation approximately 504 feet above sea level. The average annual rainfall for the past 34 years has been 42.60 inches. The average date of the last killing frost in the spring is March 16, and the first for the fall November 16. The station farm consists of 455.2 acres of land of which approximately 170 acres are occupied by the East Texas Soil Conservation Experiment Station and operated by the Soil Conservation Service of the United States Department of Agriculture in cooperation with the station. The remaining area is utilized for pasture investigations including the use of dairy cattle, agronomic, and horticultural investigations. Part of the pasture land is also being used to obtain additional erosion and run-off data on pasture land. At the present time, 35 acres are available for agronomic and horticultural crops, 150 acres are in cleared pasture, and approximately 95 acres are in woods.

The soil is predominantly fine sandy loams of the Kirvin, Bowie, and Nacogdoches series, with smaller areas of other series. The topography is quite rolling, with slopes ranging from three to twenty per cent. There is a difference of 159 feet vertical elevation between the low and high points of the station.

The principal problems of this station deal with (1) conservation, maintenance and increase of fertility, and utilization of our upland soils, which to a considerable extent are depleted by cropping and erosion, (2) the production of various agronomic and horticultural crops, (3) the pathological aspects of rose culture.

Agronomic Investigations

Variety Tests

Cotton: The cotton variety test consisted of thirteen varieties. Summerour's Hibred produced the highest yield of lint—308 pounds per acre, followed by Half and Half with 285, Rhynes Cook 273, and Rogers Acala 228. The staple lengths of these varieties were $\frac{7}{8}$, 13/16, 29/32, and 1 inch for the four varieties, respectively. On two of the six replications a heavy infestation of fusarium wilt and nematode occurred and under these conditions, only the Rhynes Cook was able to product a creditable crop. The figures given above do not include these replications. There is a distinct need in this section for a disease resistant variety having the lint characteristics of the better staple varieties.

Corn: The corn variety test included thirteen varieties and twenty-one hybrids of the Yellow Surcropper. Most of the higher yields were made by the hybrids, practically all of which produced from 15 to 25 per cent more than the Yellow Surcropper with only one falling under the latter in yield. Of the recognized varieties, Giant Yellow produced the highest yield, 31.6 bushels per acre, followed by Reese Drouth Resister, Golden June, and Mexican June. The prolific sorts again produced the lowest yields of any in the test. Considering the commercial sorts grown for three years or more, Red June and Golden June have produced the highest yields, followed by Reese Drouth Resister, Surcropper, and Giant Yellow.

Soy Beans: The variety test of soy beans included sixteen varieties, each planted at three different dates—April 5, May 2, and June 2. However, germination of the Biloxi and Tokio was so low that they were dropped from the test. In general, the relative rankings of the different varieties were approximately the same for each planting date. The Avoyelles variety made the highest average yield, followed by O-too-tan, Laredo, and Charlee with yields of 2.81, 2.32, 2.25, and 1.91 tons of air-dry forage per acre, respectively. Seed yields were very low on all varieties as usual. The Laredo and Mamloxi varieties planted at rates varying from 20 to 50 pounds per acre showed no significant differences in yield due to the variation in seeding rates.

Crop Improvement

Texas Seeded Ribbon Cane: The selfing and selection of desirable strains of Texas Seeded Ribbon Cane is now in its third year with several

desirable strains on hand. The best of these will be increased for distribution during the coming year.

Cow Peas: A very promising strain of cow peas for hay has resulted from crosses between the Chinese Red and the Iron varieties of cow peas. Comparative tests are lacking as to relative yields of this and commercial sorts but observations indicate that it will make good yields of both seeds and forage. It is the fine stem cow pea which should make very desirable hay, and is free of nematode and wilt according to the observations to date. Some work was initiated on propagation or development of wilt and nematode resistant strains of the Blackeye variety.

Soil Fertility Studies

Cotton and Corn: A test of the relative value of Hairy vetch and oats as green manure crops compared with the commercial fertilizer shown to be best by previous tests indicate that in a two-year rotation of cotton and corn, the use of Hairy vetch preceding cotton will suffice for both summer crops with yields approximately equal to those from any other treatment. The use on an additional cover crop ahead of the corn has failed to appreciably affect the yields, possibly because of the fact that they do not have time to make significant growth before the date for turning under for the early corn planting.

Previous work on amounts and grades of commercial fertilizers for cotton and corn showed that all three of the usual fertilizer ingredients can be profitably used under cotton with a rather narrow ratio of the nitrogen and phosphorus. The most profitable commercial fertilizer for cotton has been 400 pounds of 4-6-4, although 200 pounds has returned the greatest profit for money invested in fertilizer. Nitrogen alone at the rate of 16 to 20 pounds per acre has been the most profitable commercial fertilizer for corn where this crop follows a liberally fertilized cotton crop.

Dairy Cattle

The Jersey heifers used in the Mineral Requirement study in previous years came into production during the year. The classification of the heifers into the mineral and non-mineral groups was continued; those which received bone meal as heifers now receive 1 per cent of lime in the grain ration while the non-mineral animals are still on that basis. Thus far, there has been no indication of any effect of the lime upon milk flow or welfare of the animals. The number of animals available has been too small for definite conclusions.

A test during August and September on the value of feeding silage to cows on pasture, using the double reversal system, showed no advantage of such feeding. There was a surplus of pasturage available at the time.

P. R. Johnson.

Rose Investigations

Cultural Experiments: The results of the 1937-38 fertilizer experiments on field roses indicated that greater response was obtained from nitrate applications. This was contrary to 1936-37 results but was to be expected since the earlier experiments were carried out in a field that had been in pasture for at least fifteen years. The 1937-38 field, on the other hand, had been cropped for several years before roses were planted. Plants that were given a 6-9-3 fertilizer at the rate of 600 pounds per acre and had blooms and buds removed approximately every three weeks outweighed the highest yielding fertilizer treatment by fully 15 per cent, and the no fertilizer plants by about 25 per cent. This treatment also showed the lowest percentage of die-back infection.

Preliminary experiments on production of top grade one year budded plants have shown that this is possible if buds are inserted into canes in the fall before they are removed from the stock plant. Cuttings, with the bud about 2 inches above the base, are made and planted in early winter. The H. T. buds and understock buds begin growth at about the same time and after the bud is a few inches long, the understock top is removed. The scion makes rapid growth with the spring rains and by fall produces plants with a grade average of better than 1½. Under similar conditions, June budded plants will seldom make better than a No. 2 plant.

Understocks: Approximately 1,200 seeds involving forty-five combinations of the 1937 crosses have germinated. Several of the hybrids seem to have possibilities as understocks since they are thornless, fairly strong growers, and do not sucker from the roots. Several crosses involving *odorata*, hardy *Multiflora*, *canina*, etc., have possibilities of filling a need for a hardy stock compatible with *pernetianas*.

The results of understock tests at Ohio State and Cornell indicate the need of spring planting rather than late fall planting, particularly for one year June budded plants. At Ohio State, Texas Wax and manetti showed the highest per cent of live, 50 and 46 per cent, respectively; and *Multiflora* upright 9 per cent. At Cornell, all understocks seemed to do well when budded to *Radiance* but not to other varieties. A preliminary test in highly calcareous soil at Denton, Texas, seemed to indicate that manetti did better on alkaline soils than other stocks.

Approximately 23 stocks were budded for testing. *Rosa candata*, a new species under test, did exceptionally well. The cuttings rooted well, the stocks budded well, and growth of H. T. scions was exceptionally good, particularly with some of the weaker growing varieties.

Storage and Harvesting Experiments: Reports from Ohio State and Cornell indicated, generally, that of the three temperatures used for storage, 29, 32, and 35 degrees, the latter was the best. The plants in the two lower temperatures had a tendency to dry because of low humidity resulting from the frosting of cooling units.

At Ohio State, Talisman and Radiance when waxed or pruned to 12 inches before storing, survived considerably better after planting than unpruned plants. At New York State, (Cornell) a similar test indicated that 12-inch pruning was more effective than either waxing or no pruning for such varieties. At New York State, Barraclough did best when not pruned and showed highest mortality when pruned to 12 inches.

Soil Acidification Studies: Results of soil acidification studies at Denton, Texas, indicated that there is a significant increase in number of blooms with increasing degrees of acidity for the H. T. varieties Talisman and Joanna Hill but not for Radiance. Sulphur applications above 15 pounds per 100 square feet resulted in reduction of nitrates. The greater the quantity of sulphur used, the more rapidly nitrate concentration was reduced to zero.

J. C. Ratsek.

Rose Diseases

Blackspot Disease Investigations: Blackspot is still the major disease of roses in the East Texas area. Field tests to control blackspot were conducted primarily in plots of roses, varieties Luxembourg and Dame Edith Helen, in three commercial rose nurseries in the vicinity of Tyler, Texas. Previous work had shown that sulfur dust (325 mesh) and a mixture of sulfur-Cuprocide-lead arsenate (10:1:1) were suitable fungicides for use on roses. The field experiments during 1938 dealt with frequency and manner of application. The tests were planned in conjunction with disbudding treatments for the control of the cane disease die-back. In general, weekly applications of the fungicides were superior to biweekly treatment. Directing the dust downward onto the foliage was just as effective as trying to project the dust to the under side of the rose foliage. The sulfur-Cuprocide-lead arsenate mixture usually gave somewhat better control of blackspot than plain sulfur dust, but some copper or arsenate injury was noticed, and the soil was rendered toxic to the development of a successive crop. Observations were that the frequent treatments were most effective during the spring when the plant growth was most rapid. Fungicidal injury appeared to some extent during midsummer, particularly when growth was checked because of drought.

With weekly applications of the two dusts, there was little difference in soil acidity of the plots as compared with the untreated ones. Although the total number of weekly treatments was 28 for the season and approximately 460 pounds of each dust were used (calculated per acre basis) the acidification amounted only to about one-tenth of a pH.

Disbudding or pinching off the flower buds at weekly and biweekly intervals improved the size and growth of the bushes, but did not affect the percentage of blackspot.

The possibility of natural dissemination of blackspot spores (*Diplocarpon rosae*) for a distance of at least 300 feet was determined. Blackspot free

budwood (development in greenhouse) was grown on uninfected Multiflora understocks which were propagated as seedlings and isolated from other roses. The first evidence of blackspot in these plants was early in November and the nearest source of spores of the blackspot fungus was a distance of 300 feet from the isolated plot. In a second plot similarly treated but planted with uninfected cuttings of Welch Multiflora instead of seedling Multiflora, no infection was found. This plot was about 1,100 feet from the rose planting which probably supplied the spores for infection in the first plot suggesting that the distance of normal dissemination of spores of the fungus is limited.

The Welch strain of Multiflora which is the predominant kind of rose understock utilized in Texas appeared to be highly resistant to blackspot. Frequent examination at many fields throughout the major part of the growing season did not reveal a single case of blackspot. This was true even where the Welch strain was interplanted with other roses having blackspot. However, a few leaflets of seedling Multiflora (from which the Welch strain originated) were found to have blackspot in early December just before the natural leaf shedding and dormancy. A few infected leaflets of the upright strain of Multiflora (closely related to the Welch strain) were also observed in late season, indicating that although the Multiflora is not completely immune it is highly resistant to blackspot.

A study of the manner of overwintering of the blackspot fungus in East Texas revealed that although the fallen leaves of roses could carry the fungus through the dormant period, the infected leaves remaining attached to the plants and the lesions in the canes of some varieties were probably a more important means of perpetuating the disease. Fifty per cent of a planting of variety Mrs. A. R. Barraclough were observed to have symptoms of cane infection. Lesions in the stipules and petioles of attached leaves of other varieties, including Radiance, were seen during the winter.

Die-back Disease: Fields tests of disbudding or pinching off the flower buds before they opened substantiated previous work in reducing the amount of die-back. Disbudding at weekly intervals was superior to bi-weekly disbudding. The labor involved was considerable, amounting to about twelve man-hours labor per acre for each time disbudded. At best, the method of hand picking of buds would be practical with only certain of the more susceptible and expensive varieties of roses or with limited numbers of plants.

The greatest amount of die-back was usually associated with plots most affected with blackspot. The weakening of the plants due to drought also was seen to increase the occurrence of die-back.

Crown Gall and Root Knot Diseases: Preliminary studies were begun on methods to control crown gall and root knot. Treatment of rose cuttings with protectant materials such as mercuric chloride, cuprous oxide, and

shellac are being tried to prevent crown gall from starting in the tissues exposed by cutting and de-eyng.

Both carbon bisulfide and formalin injections in the soil were highly effective in controlling root knot. The method is adaptable only for small plots or in the home garden. The cost was estimated at about 35 cents per 100 square feet for carbon bisulfide ($\frac{1}{2}$ gal.), and \$1.20 for formalin ($1\frac{1}{2}$ gals.) for the same area.

Rose Rust: The rust disease of roses (*Phragmidium sp.*) was observed on *Rosa setigera* but not on nineteen other species and varieties of roses which were in the same planting.

Eldon W. Lyle.

Soil and Water Conservation Investigations

(In cooperation with the Soil Conservation Service, U. S. D. A.)

The Tyler station serves the Arkansas-Louisiana-East Texas sandy lands region, an area of approximately 33 million acres. The area is rolling to hilly with most of the cultivated slopes ranging from five to eight per cent, with some as high as 16 per cent.

The principal soils of the area are Kirvin, Ruston, Susquehanna, Nacogdoches, Bowie and Norfolk. The topsoils are generally of fine sandy loam texture.

Farming in the area is characterized by small farms, irregularly-shaped fields, small tools, and the use of large amounts of commercial fertilizers when compared with other agricultural areas. The basic cropping system is cotton and corn supplemented with a variety of specialty crops, most of which are of the erosion-permitting type.

Control Plots

The type of information obtained from small control plots is comparative for different practices and treatments and serves as an indicator in the development of erosion control methods. In addition, these plots furnish information pertaining to the fundamentals underlying the causes of erosion.

Permanent cover.

Bermuda grass, Lespedeza sericea, and forest cover are outstanding in both soil and water conservation. The destruction of forest litter by burning has increased soil losses approximately four times and water losses five times as compared with an unburned area over a period of six years.

Crop rotation with a winter cover crop.

A three-year crop rotation of cotton, grain sorghum, and cowpeas with a winter cover crop of hairy vetch over a period of 12 months, lost

an average of 15 tons of soil, whereas the check plot of continuous cotton without a cover crop lost 23 tons of soil. A large part of this reduction in soil loss may be attributed to the winter cover crop of vetch. However, the cowpeas and sorghum showed a very marked reduction in the soil losses over the cotton in the rotation.

Cultural management of erosion-resistant crops.

This study consists of sorghum-cowpea mixture planted flat in seven-inch drill widths, and 24- and 42-inch rows. The rate of seeding on the seven-inch spacing was 30 pounds of sorghum and 10 pounds of cowpeas; for the 24-inch rows was 10 pounds of sorghum and 10 pounds of cowpeas; and for the 42-inch rows was five pounds of sorghum and 10 pounds of cowpeas per acre. The plots planted in 24- and 42-inch rows were cultivated twice during the growing season, whereas, the seven-inch spacing was cultivated only one time. The results from seeding date through December 31, 1938 show an increase of forage yield on the 24- and 42-inch row spacings. The seven-inch drill spacing gave a higher per cent of total rainfall as surface run-off and a lower soil loss per acre in total run-off.

Slope characteristic.

Slope length is being studied on plots of three different lengths—36.3, 72.6 and 145.2 feet. The doubling of the slope lengths has increased the soil losses approximately one-and-one-half times. There has not been a significant difference in the amounts of rainfall lost as run-off from the different slope lengths.

Soil series.

This study includes Kirvin and Nacogdoches soils both in their normal topsoil and subsoil. The results indicate that the Kirvin normal soil is approximately three times as erodible as the normal topsoil of Nacogdoches soil. There has not been quite so great a difference in the losses from the subsoil plots. However, the subsoil plots on Kirvin have lost, over a period of years, more than twice as much soil per acre as the subsoil plots on Nacogdoches soil.

Strip cropping.

The results of this study indicate that strip cropping on short ungullied slopes of less than six per cent retards soil losses.

Watershed and Terracing Studies

An important phase of the work at this station is the measuring of run-off and soil losses from terraces with different grades, lengths, and vertical spacings. Also, field areas of different characteristics are under measurement.

Comparison of an unprotected, cultivated field with a wooded slope.

The soil losses from an unprotected, cultivated field with a gradient of 7.50 per cent, over a period of years, has averaged 46.6 tons of soil per year, while a similar soil and slope in a wooded area have lost only 0.04 ton of soil per acre annually over the same period.

Terrace grade.

The studies on terrace grade show excessive amounts of erosion and run-off from terraces with uniform grades of six inches per 100 feet and variable zero to six-inch grades. The variable-graded terrace with the lower end on a grade of three inches per 100 feet with grades gradually lessening until a level section at the upper end is attained is believed to more nearly meet the requirements for the area. Losses of soil and water from such terraces have not been excessive.

Terrace spacing.

This study is being conducted on a series of terraces under measurement. The problem is very complex since the factors entering into a study of this kind are difficult to isolate; and, consequently, definite conclusions as to the most effective and economical spacing cannot be formulated until further studies are carried out.

Terraces with strip crops.

Results of this study indicate that the location of the strip immediately above and including the terrace channel may be expected to give the maximum protection for a combination of strip cropping with terraces.

James B. Pope, S. C. S.

SUBSTATION NO. 3, ANGLETON

Substation No. 3 is located 3.1 miles northeast of Angleton, Brazoria County, adjacent to the St. L., B. & M. Railroad. The latitude is 29 degrees north and the longitude 95 degrees west with an elevation of 23 feet above sea level. The average annual rainfall over a period of 25 years was 45.67 inches as compared with 41.08 for 1938. The maximum temperature for a period of 25 years was 105 degrees F. and the minimum temperature for the same period of time was 10 degrees F., as compared with 97 degrees and 23 degrees, respectively, for 1938. The average relative humidity for a period of 24 years was 79.8% and the average annual evaporation for the same period of time was 44.699 inches. The average date of first killing frost in the fall is November 30 and of the last killing frost in the spring is March 1, giving an average growing season of 277 days.

The growing season of 1938 was characterized by a dry spring and a late freeze on April 10. The months of May, June, July and August were characterized by frequent showers which resulted in heavy insect infestations. A fair cotton crop was produced during 1938 and the corn crop

was above average. Late-planted Schrock kafir suffered severe midge damage with resultant low yields. Pastures were good during the year.

Cotton: Eighteen varieties were grown in the cotton variety test in 1938 with six replications of each variety. The cotton in this test was planted at the normal planting date and although a freeze occurred when this cotton was emerging the stands were for the most part good. The cotton suffered from heavy insect infestation during the summer months. Mebane 804-36 made the highest average yield with 371 pounds of lint cotton per acre followed in order by D. & P. L. 11A, Mebane 804, Oklahoma Triumph, Half and Half, and Sunshine with acre yields of 364 pounds, 358 pounds, 340 pounds, 336 pounds, and 326 pounds of lint cotton. For the past four years D. & P. L. 11A has made an average yield of 441 pounds of lint cotton per acre followed in order by Rogers Acala, Stoneville 5, Half and Half, Mebane 804-50, New Boykin and Oklahoma Triumph with average yields of 386 pounds, 385 pounds, 384 pounds, 381 pounds, 362 pounds, and 357 pounds per acre, respectively.

The two highest-yielding varieties for the past four years, D. & P. L. 11A and Rogers Acala, have a good length of lint and are the varieties that are being used in practically all one variety cotton communities in the Gulf Coast region of Texas. While D. & P. L. 11A has made a much higher average yield than Rogers Acala it has slightly shorter staple, slightly smaller bolls, a higher percentage of lint and in spinning tests has not proved to be as good a spinning cotton as Rogers Acala. Either variety should prove highly acceptable to cotton growers of this region.

The inbreeding studies with Mebane 804 was continued in 1938. Statistical information on the effect of inbreeding as compared with straight plant selection on the uniformity and yield of cotton is the object of this test. A number of promising plant selections have been obtained from this work and a few have proven to be superior to Mebane 804-36 in yield. Crossing work was started in 1938, using D. & P. L. 11A as the parent plant and crossing with large boll varieties in an attempt to increase the size of the boll of the parent plant.

Corn: In the corn variety test 15 varieties were grown in five replications together with 15 Yellow Surcrotter inbred hybrids and 13 Yellow Tuxpan back-crosses with the same number of replications, randomized on two acres. The weather conditions during the growing season were more favorable for the early-maturing varieties of corn than for the late-maturing varieties. Surcrotter made the highest average yield with 40 bushels per acre followed in order by Red June, Mexican June, Yellow Surcrotter, Yellow Tuxpan and White Tuxpan with yields of 39 bushels, 36 bushels, 35 bushels, 35 bushels, and 34 bushels per acre, respectively. Three of the inbred Yellow Surcrotter crosses made higher yields than Surcrotter and three of the Yellow Tuxpan back-crosses made higher yields than the Yellow Tuxpan. The varieties White June, Red June, Golden June, White Surcrotter and Yellow Surcrotter are recommended as early vari-

eties for this section and Yellow Tuxpan and White Tuxpan as the best late-maturing varieties.

The same type of corn breeding work with Yellow Tuxpan as started in 1937 was continued this year. Each year 500 ears of Yellow Tuxpan are selfed and 36 of these are selected for type and grown in four replications. The plants grown from these 36 selected ears are detasseled and crossed by massed ears selected from the highest-yielding strains from the 36 ears selected the previous year and grown in every third row throughout the test. Each year the highest-yielding strains produced in this manner are grown in the variety test in order to obtain comparable yields with standard varieties. This should increase the yield of Yellow Tuxpan and at the same time give a more desirable ear and grain type.

In addition to the above work, a Yellow Sweet Tuxpan, a Red Cob Yellow Tuxpan and a synthetic strain of yellow corn combining desirable characters of Yellow Tuxpan and Yellow Surcropper is being produced.

Schrock kafir for grain:

Schrock kafir has been the outstanding grain sorghum at this station. In a comparison of Schrock flafir and corn for grain yield, Yellow Tuxpan made an average yield of 36 bushels per acre in 1938 as compared with 27 bushels per acre for Schrock kafir. In a ten-year average comparison Tuxpan corn has made an average yield of 17.4 bushels per acre as compared with 22.6 bushels for Schrock kafir. During several of the years the corn was planted too late for a normal yield due to unfavorable weather conditions. Schrock kafir can be planted from March 1 to August 1 for grain yield and for this reason should supplement corn as a grain crop for this section.

Head selections of Schrock have been made at this station for several years which has resulted in more uniformity and a higher yield. This year the late planted Schrock strains and head selections had a severe midge and bird damage with resultant low yields.

Forage yields of corn, sunflower and sorghum varieties:

Orange sorghum made the highest yield of air-dry forage in 1938 with 7.06 tons per acre, followed in order by Schrock kafir, Red Top, Hegari, Amber, Mammoth Russian Sunflower and Yellow Tuxpan corn with 6.29 tons, 5.54 tons, 4.44 tons, 3.88 tons, 2.31 tons and 2.20 tons per acre, respectively. For the past five years Orange cane has made an average yield of 4.20 tons of air-dry forage per acre, followed by Schrock kafir with 3.98 tons and Red Top with 3.47 tons per acre. Any of these three varieties can be recommended for ensilage, although in some years Orange cane produces three cuttings whereas Schrock kafir and Red Top never produce over two cuttings in one season. Schrock kafir produces more grain than either of the other varieties and is preferred largely for that reason.

Wheat and Oats rust nursery:

A wheat and oats nursery planting of rust resistant strains was made this year. Forty-four strains of wheat and 44 strains of oats were planted in four replications. The dry spring, late freeze and heavy rainfall at harvesting time together with severe bird damage made the grain yields very low and of little value. However, notes on the resistance of the various strains to rust were obtained and many show high resistance to both stem and leaf rust.

Flax:

Eleven varieties of flax were grown in four replications. Bolley's Golden and Giza made the highest yield, 9.6 bushels per acre each. Bison was second with 8.6 bushels and Rio from College Station third with 8.1 bushels. All varieties averaged 7.4 bushels per acre. A number of field tests were made in the Gulf Coast from seed of the Bison variety furnished by Mr. H. J. Kuhn of Houston, Texas. These tests varied from a one-fourth of an acre to several acres in extent. The seed was received late and in some cases planting was delayed until January or February. Fair to good yields were obtained on most of these plantings and has resulted in a wide interest in flax as a new crop for the Gulf Coast region. A large number of plantings ranging from 10 to 200 acres were planted in the fall of 1938 in the humid Gulf Coast region.

Soy Beans:

Sixteen varieties of soy beans were grown in a variety and date of seeding test. The early planting was made on April 25 and due to unfavorable weather conditions which made continued replanting of the medium and late plantings necessary both the medium and late plantings were finally made on July 16. The early planting made about double the yield of forage than was made by the late planting. Charlee and Ootootan made the highest forage yield at the early planting with 1.79 and 1.77 tons per acre, respectively. For the past three years Laredo has made the highest acre yield of air-dry forage at the early planting with 1.49 tons per acre, followed in order by Ootootan, Delnoshat, Avoyelles, Mamloxi, White Biloxi and Mammoth Yellow with 1.32 tons, 1.24 tons, 1.17 tons, 1.16 tons, 1.12 tons and 1.05 tons per acre, respectively. The medium and late plantings have resulted in much lower forage yields than the early planting. For the past three years all seed yields have been low and of a very poor quality. While the later plantings have made slightly lower seed yields than the early planting the differences are not nearly so great as in the forage yields. The highest seed yield was made in the early planting for the past three years by Ootootan with 279 pounds per acre, followed by Mamredo with 250 pounds per acre and Avoyelles with 213 pounds per acre. The results of these tests indicate that soy beans cannot be depended upon to make a seed crop in this section of the State.

A soy bean inoculation and rate of seeding test with Mamredo was made this year, using the seeding rates of 20, 30, 40 and 50 pounds per acre. Inoculation has not resulted in increased yields of seed or forage for the past three years. The 20-pound seeding rate has given slightly lower yields of seed and forage than the other three rates of seeding. The yields from the 30-, 40-, and 50-pound seeding rates have not been significantly different.

Winter legumes:

Four winter legumes were grown in the variety test in 1938, they being the most promising varieties as determined by a previous variety test over a period of years. Hubam made the highest average yield with 1.40 tons per acre, followed by Alsike with 1.13 tons per acre, Hairy Vetch with .77 tons per acre and Yellow Annual Sweet Clover with .55 tons per acre. In an eight-year average yield these varieties have produced 1.72 tons, 1.03 tons, 1.37 tons and .56 tons per acre respectively.

Fertilizers:

A poor stand was obtained on the cotton fertilizer test this year due largely to the late freeze. Due to the erratic stands no conclusions can be drawn from the 1938 results. In a seven-year average, nitrogen and phosphoric acid have proved to be of value for cotton on the Lake Charles series soils on this station. A test comparing the use of 250 and 500 pounds of muriate of potash per acre with 400 pounds of 4-12-4 fertilizer as a blanket application on all plats has been carried for the past six years. There has been no significant difference in the potash plats as compared with the check plats. This together with the poor results shown in the regular fertilizer test with potash leads to the conclusion that potash is of little or no value on these soils for cotton.

Good stands were obtained on the corn fertilizer test but dry weather greatly reduced the yields. The use of fertilizers on corn has resulted in increased yields but it is doubtful that the fertilizers were profitable. In an eight-year average the no-treatment plats have averaged 25 bushels of corn to the acre as compared with 33 bushels for a 400-pound application of 8-12-4 and 40 bushels for an 800-pound application of 10-12-4. A test comparing cyanamid, ammonium sulphate and nitrate of soda as sources of nitrogen for corn has been carried for the past three years. Where used in a 400-pound application of 8-12-0, ammonium sulphate has produced an average yield of 24.5 bushels per acre as compared with 23.0 bushels for nitrate of soda and 21.6 bushels per acre for cyanamid. In this test a 400-pound application of 0-12-0 produced an average yield of 16.3 bushels per acre.

A pasture fertilizer test on a Carpet grass sod where the fertilizers are applied broadcast on the sod has been carried for the past three years. The no-treatment plats have produced an average yield of 2796 pounds of air-dry forage per acre as compared with 3138 pounds per

acre where an application of 80 pounds available phosphoric acid was made and as compared with 3439 pounds per acre where 40 pounds of available nitrogen and 80 pounds of available phosphoric acid were applied. These results show conclusively that the use of these fertilizers applied broadcast to the surface of an established sod is not a profitable practice.

Time and Method of Seedbed Preparation Test:

This project was started in 1932 and the land is prepared in the fall or spring or both and either bedded or flat broken or both. All combinations are used and cotton and corn are grown in a three-year rotation. The fall preparation is made as soon as the crops are harvested and soil conditions will permit and the spring preparation as soon after February 1 as soil conditions will permit. The highest average yield of cotton for the past six years was made where the soil was bedded in the fall and rebedded in the spring. This method of preparation produced a yield of 387 pounds of lint per acre as compared with 376 pounds for spring bedding only, 375 pounds for spring flat breaking and 373 pounds for fall flat breaking with spring bedding. The lowest yield was made by fall bedding with 353 pounds of lint cotton per acre. These differences in yield are not sufficiently great to influence the method of preparation.

The highest yield of corn for the past six years was made by fall bedding and spring rebedding with 30.6 bushels per acre, followed by spring bedding with 29.2 bushels per acre and fall flat breaking and spring bedding with 27.4 bushels per acre. The lowest yield has been made by fall flat breaking and spring flat breaking with 24.8 bushels per acre. There is more difference in the yields from the various methods of seedbed preparation in the case of corn than in the case of cotton. The four methods of preparation with the highest yields were the same in corn as in cotton.

Cotton Green Manure Test:

A cotton green-manure test was started in 1937 using yellow annual sweet clover as a winter green-manure crop and using a 4-8-4 fertilizer part of the phosphoric acid which was applied in the fall on some plats and all of which was applied in the fall or spring on other plats. The object of this test to to obtain the information on the effect of fall application of fertilizers or fall fractional application of fertilizers on the growth of yellow annual sweet clover and to determine their combined effect on the succeeding cotton crop. A poor growth of clover has been obtained both years and due to unfavorable weather conditions the cotton has been planted too late for good yields both years. No conclusions can be drawn from this test to date.

Rotation Studies:

Winter clovers are grown in connection with various rotations using corn, cotton, grain sorghum and cowpeas. In addition a comparison of a

three-year rotation of cotton, corn and cowpeas together with non-rotated plats of corn and cotton with and without fertilizers is being conducted. These rotations have been continued for a period of five years and no conclusions can be drawn from the data to date.

Horticultural Work

Grapes:

The grapes in the variety test at this station were injured by the freeze on April 10 but a fair crop was produced in most cases. Lomanto produced the highest yield with 10,291 pounds per acre, followed in order by Champanel, Black Spanish, Chasselas de Fountainbleau, Edna and Manito in the order named. For the past five years Lomanto has made the highest average yield of 7,822 pounds per acre, followed by Champanel with 3,885 pounds and Chasselas de Fountainbleau with 3,030 pounds per acre. Lomanto and Champanel produce a good quality of juice that blends well and are to be recommended for growing in this section. Champanel is an extremely vigorous grower and should be suitable as an arbor grape.

Strawberries:

Eight strains of strawberries produced by the Winter Haven station were grown this year in comparison with Missionary and Klondike as standard varieties. Texas 21 made the highest yield with 2,696 pounds per acre, followed in order by Texas 22, Texas 68, Texas 26, Texas 56, Klondike, Texas 15, Texas 54 and Missionary with 2,088 pounds, 2,012 pounds, 1,980 pounds, 1,680 pounds, 1,459 pounds, 1,383 pounds, 1,356 pounds and 1,193 pounds per acre, respectively. Texas 21 and Texas 22 make a very vigorous growth.

Other Fruit and Nut Variety Tests:

The peach, plum and pear crops were almost completely destroyed by the late spring freeze. Only the very early varieties of dewberries and blackberries produced any fruit this year and their production was terminated by the freeze. A few Satsuma oranges were produced and a good crop of Meyers lemons was obtained from the two trees on the station that were grown from cuttings. These two trees produced an average of 122 lemons per tree weighing 49 pounds per tree. One hundred thirty cuttings of Meyers lemon were set out in the spring and 63 of these rooted and produced trees. The tops of these lemon trees were killed back by a temperature of 23 degrees in November. The pecans produced a small crop of nuts this year. Schley made the highest yield followed by Curtis, Mayhan, Native and Stewart. These trees were planted in 1918 and have made very few nuts during this period of time. Pecans cannot be recommended as a commercial crop on the prairie soils of this section.

R. H. Stansel.

Horticultural Products Investigations

Observations on the date of fruit set were continued this year. A great many varieties set fruit before the Magnolia and most of these were capri figs. After the freezes in February and in April most of the capri figs dropped from the trees.

Over fifty varieties of figs reached maturity and were described. Extreme variation was shown in the characteristics as was indicated by the following contrasts:—date of maturity, May 23 to November 3, 1938; count per pound, 9 to 41; skin colors, yellows, yellow greens, greens, light purples, purples, and purplish blacks; skin texture, smooth to rough; stem length, very short to very long; eyes, completely closed to very large; pulp color, cream through amber to pink to red; flavor, poor, to good to excellent. Most of the varieties matured later in 1938 than in 1937.

Unpeeled figs in freezing storage at 0° F. were almost as good in quality as handpeeled figs except for some objection to the skin. Steaming the unpeeled figs for two minutes or less made the skin less objectionable but steaming for over two minutes detracted from the flavor. Gentile and Royal Vineyard varieties were not as good in quality as the Magnolia. The Gentile variety did not stand up as well in storage as the Royal Vineyard.

The quality of dried Magnolia figs was not as good this year as last. Analysis showed the SO₂ and moisture content to be lower than with the samples of last year. Of the six varieties tested, Magnolia was the best in quality, followed by Negro Largo and Gentile.

The minimum safe process for No. 2½ cans of substandard packs was found to be 50 minutes at 212° F. Swells occurred among the samples which were given less than a 50-minute process at this temperature. Preserving tests with substandard pack figs indicated that needlessly long blanching treatments or processing treatments caused the preserves made from them to be poor in texture.

Preserving tests were made on 27 varieties of figs by the standard method used for preserving Magnolia figs. Gentile, A Boise Jaspee, Bourjassotte, and Negro Largo were judged by a group of canners to be equal in quality to Magnolia preserves from the standpoints of appearance, texture, and flavor. Grasse Violet de la Fretti was better in appearance than Magnolia and nine other varieties were equal in appearance. A Boise Jaspee was better and 15 other varieties were equal to Magnolia in texture. Negro Largo was considered by some of the judges to be outstanding in flavor and 16 other varieties were equal to Magnolia in flavor. Of the eight varieties tested in the light sirup pack Gentile was the best although Negro Largo was outstanding from the standpoint of flavor.

Comparative preserving and freezing tests were made between Klondike and Missionary strawberries and some of the strains which were developed at Substation No. 19 with the following results:

Strawberry preserves.—In appearance three Texas strains, Nos. 54, 56, and 15 were superior to Missionary and Klondike; Klondike was superior to any of the Texas strains in texture but was followed by Nos. 15 and 21, which were better than Missionary; in flavor No. 54 was judged better and Texas 56 equal to Klondike and these were followed by Nos. 15 and 68, which were better than Missionary.

Frozen pack.—Klondike was the only commercial variety used in these tests. In appearance Texas 54 and 68 were superior to Klondike; all of the Texas strains were superior to Klondike in texture and Texas 15 had the best texture followed by 21 and 54 and then 26 and 56; Texas 54 and 22 were superior and Texas 65 was equal to Klondike in flavor.

Harold M. Reed.

SUBSTATION NO. 4, BEAUMONT

Substation No. 4 is located six miles west of Beaumont on the Houston road at latitude 30 degrees north, and longitude 94 degrees west. The elevation is 26 to 30 feet above sea level. The station comprises 100 acres of land consisting largely of Lake Charles and Crowley clays, which are representative soils of the region. The total rainfall during 1938 was 50.51 inches as compared to a 25-year average of 53.06. The 1938 growing season was 280 days as compared to a normal of 268.

Rice Investigations

(Cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture)

Variety Test

Fifteen rice varieties were grown in replicated 1/50-acre plats in 1938. The varieties were divided into early, midseason, and late maturity groups. Each group was sown in a separate randomized block with the Shoemed variety as a check. In the early maturity group, Shoemed, Zenith, and Edith, with yields of 46.7, 42.6, and 42.1 bushels per acre, respectively, were significantly higher yielding than Early Prolific and Lady Wright with yields of 36.2 and 33.6 bushels, respectively. Latex, with a yield of 40.6 bushels per acre, was significantly higher yielding than Lady Wright. In the midseason group, Fortuna, Acadia, Caloro, and Nira, with yields of 48.1, 47.4, 40.6, and 39.5 bushels per acre, yielded significantly higher than Shoemed and Delitus with yields of 34.5 and 27.1 bushels. Fortuna and Acadia were also significantly higher yielding than Caloro and Nira. In the late maturity group, Rexoro with a yield of 59.9 bushels per acre, was significantly higher in yield than other varieties that yielded as follows:

Iola, 45.3; Blue Rose T. S. No. 7183, 41.9; Shoemed, 37.2; and Supreme Blue Rose, 36.7 bushels. Iola yielded significantly higher than Blue Rose, Shoemed, and Supreme Blue Rose, while the three latter varieties did not differ significantly, although the Blue Rose T. S. No. 7183 averaged 5.2 bushels higher than Supreme Blue Rose.

Nursery Experiments

Sixteen early- and midseason-maturing varieties and selections were grown in duplicate tests on farms located near China and Stowell, Texas. The varieties were sown in 4-row 16-foot plats with the rows spaced 9 inches apart. A modified Latin square design was used in seeding each test. At Nome, the yields varied from 67.5 bushels per acre for Early Prolific selection No. 3214 to 38.9 bushels for Louisiana Early Blue Rose. Commercial Early Prolific sown as a check variety averaged 52.6 bushels. Other high yielding strains in the order of yield were an Edith x Blue Rose hybrid selection, Zenith, and an Edith x Fortuna hybrid selection. Early Prolific selection No. 3214, the Edith x Blue Rose hybrid selection, and Zenith yielded significantly higher than Lady Wright, while Louisiana Early Blue Rose yielded significantly lower than Lady Wright. In the test near Stowell, Texas, on virgin soil, the yields varied from 72.8 for Early Prolific selection No. 3214 to 50.7 bushels for Louisiana Early Blue Rose. Early Prolific selection No. 3214 and the Edith x Fortuna strain which was fourth in the Nome test yielded significantly higher than Lady Wright. In both tests Early Prolific selection No. 3214, an Edith x Fortuna hybrid selection, an Edith x Blue Rose hybrid selection, and Zenith produced the highest yields, averaging 70.1, 61.3, 61.0 and 59.8 bushels per acre, respectively. Shoemed averaged 54.2 and Lady Wright 52.4 bushels. Louisiana Early Blue Rose, the lowest yielding variety in each test, averaged 44.8 bushels.

One hundred and fifteen varieties and selections were grown in 3-row 16-foot plats with rows spaced 12 inches apart. The varieties and selections were divided into early, midseason, and late maturity groups, Shoemed being sown as a check variety in each group. In the early maturity group yields of rough rice varied from 50.1 bushels per acre for a Colusa x Blue Rose hybrid selection to 26.5 bushels for Louisiana Early Blue Rose. Early Prolific yielded 41.7 bushels, Shoemed 37.9 bushels, and Lady Wright 35.7 bushels. Zenith yielded 42.9 bushels per acre and two Edith selections 44.6 and 38.8 bushels. Four hybrid selections from the cross Edith x Fortuna also yielded over 45.0 bushels per acre and are of similar maturity to Edith and Lady Wright. The leaves and leaf sheaths of these selections die quite rapidly upon maturity of the grain, being worse in this respect than either the Edith or Fortuna parent. There were, however, four Edith x Fortuna hybrid selections in this test yielding as high as Lady Wright that do not possess this tendency to die at maturity of the panicle and they are in addition relatively resistant to *Cercospora oryzae*. In the midseason group yields varied from 48.4 bushels for Fortuna to 28.1 bushels

for a Colusa x Delitus hybrid selection. Other varieties yielding more than 44.0 bushels per acre were Acadia, an Edith x Blue Rose hybrid selection, a Caloro x Blue Rose hybrid selection, an Improved Blue Rose x Fortuna hybrid selection, C. I. No. 4060, C. I. 4440, and Creole Bred. Shoemed averaged 34.6 bushels, Caloro 43.5 bushels, Nira 43.3 bushels, Calady 40.3 bushels, and Delitus 29.5 bushels. Hybrid selections possessing promising agronomic characteristics with yields above 43.0 bushels per acre were two Kameji x Blue Rose hybrid selections and a Rexoro x Delitus hybrid selection. The Kameji x Blue Rose selections have grain qualities similar to those of Blue Rose and show marked resistance to *Helminthosporium oryzae* and *Cercospora oryzae*. The Rexoro x Delitus selection has a slender-grain type similar to Rexoro but matures approximately thirty days earlier. In the late maturity group yields varied from 60.0 bushels per acre for Rexoro to 35.4 bushels for a Kameji x Blue Rose hybrid selection. Blue Rose (T. S. No. 7183) yielded 49.4 bushels per acre as compared to 40.9 bushels for Supreme Blue Rose. In the field plot variety test these same strains yielded 41.9 and 36.7 bushels, respectively. A Kameji x Honduras hybrid selection yielded 57.3 bushels, a Colusa x Blue Rose hybrid selection 52.7 bushels, and a Kameji x Blue Rose hybrid selection 51.6 bushels. Acadia, also grown in the late maturity group, yielded 48.8 bushels as compared to 47.2 bushels in the midseason group. Shoemed yielded 37.9, 34.6, and 35.9 bushels in the early, midseason, and late maturity groups, respectively.

A preliminary yield nursery of 87 varieties and selections was grown in triplicated 4-row 9-foot plats with the rows spaced 9 inches apart. Seventy-seven of the selections grown in this test were of hybrid origin. Approximately twenty of these hybrid selections will be advanced to replicated 3-row 16-foot plats in 1939. Many of the selections to be advanced in 1939 show marked resistance to *Cercospora oryzae* and appear to be more resistant to *Helminthosporium oryzae* than the commercial varieties.

Source of seed and methods of seeding experiments started in 1937 were continued in 1938. Varieties obtained from Biggs, California; Stuttgart, Arkansas; Crowley, Louisiana; and Beaumont, Texas, were grown in the source of seed experiment. Transplanting and drill methods of seeding were compared in the methods of seeding experiment.

Twenty-seven advanced generation bulked hybrid populations were grown in triplicated 4-row 16-foot plats. This was the second season that this test has been conducted. Two of the bulked hybrid populations yielded higher than Blue Rose (T. S. No. 7183) and eighteen populations yielded higher than Shoemed.

The space-sown breeding nursery included 2,296 panicle selections from advanced generation crosses. A total of 72 different crosses were represented in this material and the selections varied from F³ to F¹⁰. Approximately 60 selections were saved for the purpose of testing in the pre-

liminary yield nursery in 1939. At least 1,500 panicle selections were made from this material to be grown in a similar nursery in 1939.

For the purpose of obtaining inheritance data, 1,178 F^3 lines from eleven different crosses were grown in space-sown rod rows. This is a part of inheritance studies started in 1936.

A leaf spot nursery of 368 varieties and selections was grown in 2-row 8-foot plats for the purpose of recording varietal reaction to *Helminthosporium oryzae*, *Cercospora oryzae*, and *Entyloma oryzae*.

H. M. Beachell, E. C. Tullis, Bu. Pl. Ind.

Rice Variety and Date of Seeding Test: This test included two early, two medium late, one late, and one very late maturing varieties. Early Prolific and Latex were the earliest maturing varieties at each date of seeding, and Rexoro was the latest. Texas Fortuna and Nira were slightly earlier than Blue Rose at the earlier seedings and later when seedings were made late in the season. All late plantings required less time for maturing than earlier seedings. Early seedings produced larger yields than real late seedlings, but the heaviest yields were from the plantings made from April 10 to May 20.

Rice Rate of Seeding: The largest yield of 2359 pounds of rough rice per acre was obtained from the lightest seeding of 60 pounds of seed per acre. As the rate of seeding increased there was a slight decrease in yield. However, growing conditions were very favorable, and the test was grown on a rather light soil. The heavier rates would probably have shown up to better advantage on a heavier soil, and under less favorable conditions for good germination of seed.

Rice Rotations: The yields were heavier than usual on all plats this season. However, the heaviest yields, approximately 11 per cent larger than from plats cropped continuously to rice, were produced by the rotations that included soy beans and Sesbania. There was very little difference in the yields obtained from these two rotations.

Weed Control With Acid Solutions: Solutions of sulphuric acid of ten, fifteen and twenty per cent by weight were used for spraying plats of young rice for the control of weeds. Good control was obtained, and some very noticeable increases in yield were recorded on some treatments. Either the fifteen or twenty per cent solutions were somewhat more effective than the ten per cent solution. All sprayings were made at the rate of 120 gallons of solution per acre.

Cooperative Rice Fertilizer Tests: A test using five treatments and a no treatment was conducted at two locations on this station and on one farm near Nome and another near Devers. The test at Devers showed very light increases in yield from the use of nitrogen alone or in combination with phosphoric acid. An increase of 18 per cent in yield was obtained from the use of nitrogen alone on the old land at this station,

and a complete fertilizer increased the yield to 26 per cent. The largest increases in yield were obtained in the test near Nome in which 100 pounds per acre of Sulphate of Ammonia increased the yield approximately 31 per cent. Phosphoric acid was of no value at Nome.

Rice Fertilizer Test: The results obtained in the large field plats at this station were very similar to those of preceding years in that nitrogen produced the most noticeable increases in yield, and increasing the amount of nitrogen gave an additional increase in yield of rice. Sulphate of ammonia, used as a source of nitrogen, used at the rate of 200 pounds per acre produced 2438 pounds of rice per acre as compared to 1910 pounds on unfertilized plats. Phosphoric acid alone was of no value, but the addition of 100 pounds per acre of superphosphate to the 200 pound rate of sulphate of ammonia gave a yield of 2994 pounds of rice per acre.

Methods of Applying Fertilizers to Rice: Sulphate of ammonia and superphosphate were used at the rate of 150 pounds per acre each. These were applied separately and in combination on top of the soil and in the drill with the seed. Superphosphate alone did not increase the yield to any noticeable extent. Sulphate of ammonia alone produced an increase of approximately 14 per cent with no difference between being placed on top of the soil or with the seed. A combination of the two produced the largest increases. This combination increased the yield 16 per cent when applied on top of the soil and approximately 24 per cent when placed in the drill with the seed.

Sources of Nitrogen and Phosphorus: Regular and granular sulphate of ammonia, cyanamid, and nitrate of soda were used as sources of nitrogen, and the regular and granular superphosphate, bone meal, and calphos were used as sources of phosphoric acid. As former work indicates very little, if any, increase from phosphoric acid alone, sulphate of ammonia was used in combination with all materials supplying phosphoric acid. Superphosphate was added to all nitrogen treatments. Nitrate of soda produced a slightly larger increase in yield than either form of sulphate of ammonia. Granular superphosphate produced slightly larger yields than bone meal or the regular superphosphate. With the exceptions of cyanamid and calphos, these increases were from approximately 55 to 63 per cent. Cyanamid should not be used in the drill with the seed on account of injury to the seed. Calphos was inferior to the superphosphate and bone meal.

Effects of Fertilizers on Germination of Rice Seed: Sulphate of ammonia and superphosphate were used separately and in combinations of 50 to 250 pounds per acre each on four varieties of rice. The fertilizers were applied in the drill with the seed. These treatments did not injure the germination of the seed indicating that these fertilizers can be applied to rice, under field conditions, by placing them in the drill with the seed.

Cylinder Experiments With Fertilizers on Rice: The results obtained in this test were different from those from the field plats. The results in the cylinders cropped for the sixth consecutive year showed an increase of 107 per cent in straw, and 90.57 per cent in grain from the use of 150 pounds per acre of superphosphate. Increasing the amount of superphosphate or the addition of sulphate of ammonia and potash did not produce any additional increases. The use of 100 pounds of sulphate of ammonia alone increased the yield of straw 15.02 per cent and the grain 14.46 per cent. The use of 200 pounds of sulphate of ammonia per acre produced much lighter yields than the 100-pound rate.

In the cylinders used for the fifth consecutive year in comparing sulphate of ammonia and ammoniated peat, the use of 200 pounds per acre of sulphate of ammonia increased the yield of straw 6.67 per cent and the grain 8.61 per cent as compared to an equivalent amount of the ammoniated peat producing increases of 11.30 and 27.05 per cent, respectively. The use of 300 pounds per acre of superphosphate increased the yield of straw 40.58 per cent and the grain 28.69 per cent as compared to 43.19 and 32.79 per cent, respectively, for the equivalent in bone meal.

Sulphur on Rice Soils in Cylinders: This is a continuation of the test conducted in 1937 to determine the tolerance of rice plants to various degrees of acidity and alkalinity. All applications of sulphur and lime for obtaining the pH values of 4 to 8, respectively, were made in 1937 and not repeated in 1938. The soil in the cylinders receiving the heaviest sulphur treatments showed the lowest pH of around 4.1 to 4.7 at the time of planting, but shortly after the irrigation water was applied there was a noticed increase in the pH of the soil in all cylinders to around 6.2 to 7.5. The plants in the cylinders with soil of around 4.0 to 4.5, at the start of the season, made very poor growth, and produced the lightest yields of both straw and grain. The yield of straw showed some increase as the pH increased. The largest yields of grain were produced in the cylinders containing soil that showed a pH of around 5 to 6. The use of fertilizers produced a slight increase in yield of both straw and grain.

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Rice Diseases

Distribution of the black kernel disease: Surveys made during the spring and fall of 1938 indicated that the black kernel disease of rice was fairly universal throughout the rice growing area of Texas. Previously the eastern part of the State had been most seriously affected, but at present the most damage occurred in the area west of Houston. Fortuna was reported as suffering the greatest damage in the 1937 crop, but the disease was reported in about an equal number of times in the Fortuna and Rexoro of the 1938 crop. Other varieties in which the disease was found were as follows: Delitus, Blue Rose, Nira, Early Prolific, Lady

Wright and Japanese. There was much less damage to the 1938 crop than the 1937.

Fungi recovered from discolored rice kernels: Approximately 1200 black kernels were sterilized externally, by dipping in a 1-1000 bichloride of mercury solution, and cultured on non-nutrient agar. By far the most frequently recovered organism was *Curvularia lunata*, occurring well over 50 per cent of the time. Other organisms which occurred were as follows in order of prevalence: *Helminthosporium oryzae*, *Fusarium* sp. *Trichoconas caudata* and *Basosporium gallarum*.

Inoculation of rice plants with fungi and discolored kernels: Inoculation of rice seeds by applying pure cultures of fungi, recovered from black kernels, as well as the ground black kernels, at the time of planting, had no effect on the number of discolored grains produced in the harvest. Inoculating the growing plants at different intervals during the growing season caused no increase in the number of diseased kernels produced.

On the other hand, inoculations at the time of flowering with ground black kernels produced as high as 23 per cent black kernels. Inoculations with *Curvularia lunata* produced 10.7 per cent black kernels, while incubating these grains at 35° C. for two weeks increased the depth of color and the number of discolored to 13 per cent black.

Planting diseased seed and selected black kernels produced plants, but in no case was there any evidence that the disease was carried by the seed.

Post harvesting experiments and their effect on the black kernel disease: Shocks of rice inoculated with pure cultures of fungi, isolated from black kernels, as well as the black kernels themselves and kept under either damp or field conditions did not show any variation in the number of black kernels produced. Under the damp condition, insect "pecks" seemed to increase in area and intensity and appear black. However, in most of these cases the kernels would not mill and so would not be very detrimental to the crop.

Rice harvested prematurely, ripe and over-ripe and left in shock for several weeks showed no variation in the number of black kernels.

The influence of various fertilizers on the number of black kernels and the yield of rice: Experiments with different combinations of fertilizers at Beaumont, Stowell, Katy and Angleton showed that the most practical fertilizer was a combination of ammonium sulfate (100 pounds per acre) and superphosphate (126 pounds per acre). Increases over this application were found at Beaumont and Stowell by adding 40 pounds of muriate of potash per acre, but the increase in yield was not sufficient to warrant the extra expense. The addition of zinc, iron, manganese and boron to the fertilizer had no beneficial effect on yield. In several cases a definite

decrease was obtained. Fertilizer treatments had no apparent effect on the number of black kernels.

Alan L. Martin.

Field Crop Investigations

Cotton Varieties: The 1938 yields of cotton were fairly heavy as compared to former years. All but five varieties produced more than 200 pounds of lint per acre. D. & P. L. 11A produced the heaviest yield of 334 pounds of lint per acre, and Delfos was next with 315 pounds. None of the other varieties produced yields of above 300 pounds. Qualla produced the lightest yield of 171 pounds of lint per acre. With one exception, the varieties maturing the largest part of the crop at the first three pickings produced the largest yields.

Corn Varieties: The yields of corn were the lowest recorded at this station during the past ten years. Heavy rains that flooded the plats during the early growth of the plants was probably the main cause for the low yields. White Tuxpan produced the largest yield of 12.3 bushels per acre. Four other varieties produced ten bushels or more. Paymaster produced the lightest yield of 4.9 bushels per acre.

Perilla and Chia: Small plantings of Chia and several varieties of Perilla were made in 1938. Chia did not mature any seed as the crop was killed by frost before the seed matured. The yields of Perilla were very light, the heaviest being slightly above 300 pounds of seed per acre.

Forage and Pasture Crop Investigations

Pasture Fertilization: All fertilizer treatments showed some increase in yield during 1938, but in general the greatest increases were obtained from treatments including superphosphate. The use of 160 pounds of superphosphate alone increased the yield approximately 150 per cent, and 160 when 80 pounds of sulphate of ammonia was added. In all cases the use of lime produced an additional increase in yield of forage with lime alone increasing the yield approximately 58 per cent. Nitrate of soda produced slightly larger yields than sulphate of ammonia, but either of these alone produced lighter yields than superphosphate. The use of a combination of 80 pounds of sulphate of ammonia and 160 pounds of superphosphate on limed plats increased the yield approximately 243 per cent over unfertilized plats not limed and 118 per cent over limed plats not fertilized. Potash produced a very slight increase in yield.

Horticultural Crops Investigations

Citrus: A light crop of fruit was produced by the eight Satsuma orange trees, and the Meyer lemons. The yield on the Satsumas was from 42 to 140 fruit per tree. The yield varied very noticeably among the lemon trees, but the average was around 8 dozen per tree. A temperature of

23 degrees on November 25, 1938, injured the lemon trees, and froze the larger part of the fruit.

Peaches: Two of the peaches, S. P. I. Nos. 43134 and 55563, received from the Bureau of Plant Introduction in January, 1932, produced 22 and 13.5 pounds of fruit each, respectively. The quality of the fruit was very poor.

Pears: The two trees of Hybrid pear, T. S. No. 7493, produced 104 and 117 pounds, respectively.

Tung Oil: The growth of these trees, which were planted February 20, 1936, was very poor in 1938. A few trees matured a light crop of nuts.

R. H. Wyche.

SUBSTATION NO. 5, TEMPLE

Substation No. 5 is located 2 miles south of Temple and one-half mile west of the Temple-Taylor highway No. 95. The latitude is $31^{\circ} 3'$ north, the longitude $97^{\circ} 21'$ west, and the elevation 660 feet above sea level. The average annual rainfall over a period of 26 years, 1913 to 1938, inclusive, is 34.93 inches, while for 1938 it was 27.86 inches. During the 26-year period an average of only 6.45 inches of rain fell in the months of June, July, and August. The rainfall for these months in 1938 was 5.61 inches. The 26-year average rainfall for the 6 months period, May to October, inclusive, is 17.92 inches, while 11.47 inches fell during these months in 1938.

The Station consists of a total of approximately 647 acres of land, 106 acres of which are leased. The soil on the Station is typical of the Blackland region and is predominantly of the Houston series. All land is in cultivation except that occupied by farmsteads, roads, ditches, and natural drainage ways. There are approximately 34 acres of pasture along Boggy Creek, which is the major drainage way through the Station.

The purpose of this station is to aid the development of the agriculture of the Blacklands, particularly through the solution of the major crop and soil problems of the region. The soils of the region that have been well preserved are very fertile and are admirably adapted to the growing of cotton, corn, grain sorghums, and small grain. The objectives of this station are: the control of the cotton root-rot disease; the prevention of soil erosion; the introduction, testing, and improvement of crop varieties; the improvement of soil fertility; and the study of various cropping systems. The cotton root-rot problem is being studied by the station under supervision of the Division of Agronomy and the Division of Plant Pathology and Physiology of the Texas Agricultural Experiment Station and in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture. The soil and water conservation problem of the area is being studied by the Soil Conservation Service, Division of Research, of the United States Department of Agriculture, in cooperation with the station. During the last two years, livestock projects to supplement cotton farming have been instituted.

Cotton Root-Rot Investigations

(In cooperation with Bureau of Plant Industry, U. S. D. A.)

Cotton root rot on this station farm and throughout this vicinity was comparatively light in 1938. Some of the areas that ordinarily show from 50 to 75 per cent had only about 25 to 30 per cent infestation. The average for Bell County was approximately 20 per cent. There was the usual sharp increase in root rot in the fall, probably due to the 1.12 inches of rainfall on September 11.

Effect of Continuous Cotton, Corn, Sorghum, and Oats, on the Number and Viability of Sclerotia: Parts of acre F-6 on the substation have been planted continuously to the same crop since the station was established in 1928. The average of two different samplings taken in January and in August shows a total of 13,469 sclerotia from continuous cotton plots, 11,396 or 84.6 per cent of which were viable. The average of all grain plots shows a total of 9,765 sclerotia, 6,870 or 70.4 per cent of which were viable. There were approximately twice the number of viable sclerotia in continuous cotton as in the average of all grain plots. Samples were taken at one-, two-, and three-foot depths at the usual 320-posthole auger rate per acre. These 320 posthole samples represent approximately 1/500 of the total volume of soil in an acre to the three-foot depth.

Number and Viability of Sclerotia from an Eight-Year Clean Fallow: Part of acre E-6 on the substation has been in clean fallow since the season of 1930. At the 320-posthole sampling rate per acre to the 3-foot depth, 3,644 sclerotia were obtained, 1,990 or 54.6 per cent of which were viable.

Number and Viability of Sclerotia from a Native Meadow: Soil samples taken in a native meadow in part of the land recently purchased by the Soil Conservation Service showed a total of 3,326 sclerotia, 1,327 or 39.9 per cent of which were viable. Three hundred twenty posthole samples were taken with a 6-inch posthole auger in different locations over this area has never been cultivated. The area is covered by native grass.

Root Rot in Cotton Planted for the Second Successive Year on a Native Meadow: Root rot counts were obtained in cotton planted for the second successive year on a native grass meadow in 1938. Counts were made on each tenth row over the entire area, about 20 acres in size, on October 5. There was an average of 50 per cent of the cotton plants killed by root rot this year. In 1937, when the meadow was broken for the first time and planted to cotton, there was an estimated end-season average of approximately 90 per cent root rot. In the years prior to 1937 a number of common native weeds susceptible to root rot were observed growing at close intervals over the meadow.

Effect of Oil and Cotton Bur Ashes on Control of Cotton Root Rot: Oil barriers have been used in attempts to prevent the spread of cotton

root rot and farmers have reported reduction in root rot where ashes were applied. Crude oil and crank case drainings were applied in field plots at rates varying from 2,000 to 15,000 gallons per acre. Some burning of seedlings occurred in the 2,000-gallon per acre plots and little or no stand was obtained at rates higher than 2,000 gallons. Yields varied from 0 in the 15,000-gallon rate plots to 225 pounds seed cotton per acre for the 2,000-gallon rate plots and 423 pounds for the check. A yield of 236 pounds seed cotton was obtained from the 2,000-gallon rate of crank case drainings. In the 8,000-gallon per acre rate of crude oil, 6.7 per cent root rot occurred; in the 4,000-gallon rate, 3.2 per cent; in the 2,000-gallon rate, 12.9 per cent; and in the checks, 48.2 per cent root rot occurred. In the 2,000-gallon rate of crank case drainings, 5.9 per cent root rot occurred, and 42.5 per cent root rot occurred in the accompanying checks. Cotton bur ashes had little effect on root rot or yield.

Quality of Cotton Seed from Plants Killed at Different Dates by Cotton Root Rot: Analyses of seed from cotton plants killed at different dates during the 1938 growing season by root rot showed a variation in oil content from 9.53 per cent for the earliest killed plants to 18.22 per cent for plants killed at the end of the season. Protein content varied from 19.56 per cent for seed from plants killed at the earliest date in the season to 22.56 per cent for plants remaining green or killed in the end of the season. Analyses of plants killed at different dates during the 1936 season were made in January, 1938. These results are similar to those for 1938 and previous years. Oil content varied from 8.88 per cent for seed from plants killed on July 15 to 15.78 per cent for seed from plants remaining green at the end of the season. Protein content varied from 18.19 per cent for seed from plants killed at the earliest date of July 15, 1936, to 20.94 per cent for seed from plants killed at the latest date of September 15.

Enough seed were left after analyzing the 1936 crop to plant in 1938 for determining the effect of different date of kill of plants on the germination of seed from these plants. Germination varied from 4.2 per cent for seed from plants killed July 15, 1936, to 68.1 per cent for seed from plants killed at the latest date of September, 1936. Yields varied from 176 pounds seed cotton per acre from seed from plants killed July 15 to 694 pounds seed cotton per acre from seed from plants killed September 1, 1936. There was very little difference in root rot in these plots.

Selections of Cotton Plants for Resistance to Root Rot: Plants of Qualla cotton remaining green in the midst of root rot infected plants that were inoculated a number of times were harvested and the seed planted this year. Such selections have been made for a number of years. There was approximately the same amount of root rot in the apparently resistant plants as in check plots. There was 43.3 per cent root rot in resistant plots and 47.7 per cent in check plots. There is apparently no

resistance carried over from year to year by seed from such seemingly resistant plants.

Comparative Resistance of Brabham, Iron, and Blackeye Cowpeas to Root Rot: At the time of harvest on August 27, Blackeye cowpeas had a root rot kill of 62.6 per cent; Brabham cowpeas, 2.5 per cent; and Iron cowpeas, 1 per cent. Yields of seed were: Blackeye, 666.6 pounds; Iron, 363 pounds; and Brabham, 478.5 pounds per acre. Blackeye peas yielded 2,805 pounds of green forage (less seed); Iron, 14,949 pounds; and Brabham, 13,299 pounds of green forage per acre. Dry weights were 726 pounds, 2,244 pounds, and 2,079 pounds per acre respectively. Neither Iron nor Brabham cowpeas show the chlorotic condition typical of Blackeye peas and most other cowpeas grown in the Blackland.

Soil and Water Conservation Investigations

(In cooperation with the Soil Conservation Service, U. S. D. A.)

Soil and water conservation investigations at the Blackland Experiment Station, Temple, Texas, have been in progress since 1929. This work is applicable to the Blackland region of Texas and to parts of the Grand prairie. It is estimated on the basis of a reconnaissance erosion survey made in 1934 that out of a total of some 9,500,000 acres of crop land in the Blackland region more than 7,700,000 acres needed protection from erosion. The Grand Prairie, lying to the west of the black prairie, has climatic and certain soil conditions so comparable to the Blackland region that at least a part of the area may be considered as being served by this station. Here and in the remaining area of the Blackland approximately 5,600,000 acres of grass land have been badly overgrazed, and resultant soil and water losses have seriously decreased the livestock carrying capacity. The total area served by this station so far as soil and water conservation investigations are concerned is approximately 15,000,000 acres.

General Control Plat Work: The size of the plats in this study will limit the application of certain results to being indicators by which soil and water conservation practices may be developed. The results from this study are briefly enumerated as follows:

1. Sod-forming grasses, such as Bermuda, and close growing cultivated crops, such as oats, sorghum, and Sudan, are very effective in reducing soil and water losses.

2. Severely eroded Houston black clay is less retentive of moisture than the original surface soils; it is only about one-third as productive as the top soil, and this difference is increased during dry years.

3. On a 4 per cent slope Houston black clay soil a 3-year rotation of cotton, corn, and oats reduced soil and water losses to about three-fifths that of continuous corn. This effect is due primarily to the control exhib-

ited by oats when it occupies the land. The effect of the same rotation was not quite so great on a 2 per cent slope Houston black clay soil; the loss of soil from the rotation was about two-thirds that of the continuous corn, and the water loss was four-fifths.

4. Plats in a rotation of cotton, corn, and oats, with rows across the slope, lost one-third as much soil and one-half as much water as plats with rows up and down the slope.

Terrace Investigations: There are 20 terraces which are equipped for measuring soil and water losses as a means of determining the effect of different design characteristics, such as grade, vertical spacing, and length. Results to date indicate that:

1. Level terraces with closed ends cannot be used satisfactorily in this area on Houston black clay soils.

2. Level terraces with open ends have a tendency to drown out crops in the channel during wet years.

3. Level terraces with closed ends and four-inch tile drains two feet under the terrace channel perform no better than closed-end terraces on Houston black clay soils.

4. A terrace grade not greater than 3 inches per 100 feet is more satisfactory from a standpoint of both soil and water losses, with a variable grade being most effective.

5. Soil losses decrease with a decrease in vertical spacing of terraces.

6. A terrace length of about 2,000 feet is probably the maximum that should be used for this area.

7. There is no optimum length of terrace from the standpoint of soil and water losses. A suitable outlet is the greatest determining factor in the length of terraces under 2,000 feet.

8. Terrace outlets and outlet ditches must be protected; both structures and vegetation are being used successfully for this purpose.

Strip-Cropping Investigations: Experimental installations for this study have been very limited up to the latter part of 1938, at which time a substantial amount of work in strip-cropping investigations was approved and is briefly outlined herein under the title "Recently Approved Projects in Soil and Water Conservation Investigations on Which Work was Started in the Latter Part of 1938." Heretofore there have been five plots devoted to strip-cropping studies. These plots have shown definitely that contour strip-cropping is effective in conserving soil and water as compared to the destructive practice of cultivating up and down the slope. The strip-cropped plat having the greatest removal of soil and water lost only about one-eighth as much soil and about one-half as much rainfall in the form of run-off as did the check plat with rows down slope. The treated plot

in this study was on a land slope of 4 to 6 per cent and had four crop strips, two of oats and two of cotton, 75 feet in width, alternating, and rotated each year. The other of the five plots referred to were on land slopes of 2 and $3\frac{1}{2}$ per cent. The strips were not rotated and were adjacent to the catchment devices. The losses were naturally considerably less than from the plots previously mentioned, but this type of strip-cropping using cultivated crops is not necessarily recommended.

Protection of Eroded Lands by Revegetation: About 50 different species of grass are being propagated on the Station. These propagating areas are fenced, and palatability rates are being made on the grasses. This study has not progressed to such a point that very conclusive statements can be made, but results indicate that there are a large number of native grasses and a number of introduced species that may be used profitably in the revegetation of eroded lands. In addition, a number of running type grasses have shown promise as vegetation for use in the control of terrace outlets.

H. O. Hill.

Effectiveness of Strip-Cropping: The field layout to determine the relative effectiveness of an erosion-resisting crop, when occupying the same proportion of land in a strip-cropping system, as compared to a crop rotation system, will consist of 12 plots 432 feet long, and 151 feet wide on a slope of approximately 2.5 per cent. These 12 plots will have six duplicated treatments as follows: two will be planted to corn, two to oats, two to cotton, and six stripped with cotton, corn, and oats, each crop planted in strips 36 feet wide, the strips rotated in a three-year rotation so that each crop occurs in the same relative position each year. The singly-cropped plots will be planted in the same type three-year rotation—cotton, corn, and oats. All crops will be planted on the contour. These 12 plots will be equipped with small type "H" flumes and float recorders to measure rates and amounts of run-off from the various treatments. Concrete concentrating troughs, concrete silt boxes and Geib divisors will be used to determine the soil losses.

Other studies in strip-cropping and the evaluation studies which are now in progress on the operations projects are not equipped with installations to measure the soil and water losses from the areas under observation. On the 12 plots of this study, supplementary measurements and records will be made of rill formation, gullies, and soil depositions after each rain; and in addition, surface profiles will be made at the start of the experiment and periodically while it is in progress. An attempt will be made to correlate these measurements with the soil and water losses as determined by the installations. By this supplementary study, we should be able to determine what erosion phenomena are the best index to the efficiency of an erosion control practice. Yields will be taken in order to determine production of fields planted to a single crop as compared with fields planted to strip-crops—all crops being in the same rotation.

This work is planned in such a manner that the data will be subject to statistical analysis.

Design of Strip-Cropping: In order to determine the optimum design and relative effectiveness of width of strips, the ratio of erodible to resistant strip widths and the limitations of the control measure with respect to length and degree of slope, field layouts of different designs will be installed on the station land. Measurements and records will be made of rill formation, gullies, and soil depositions after each rain; and in addition, surface profiles will be made at the start of the experiment and periodically while it is in progress. Studies will also be made of the concentration of water due to the breaks in the bedded furrows of strip-cropped fields. Crop yields will be taken to determine some of the economic factors involved in the practice of strip-cropping and to compare the productiveness of crops in strips to areas planted solidly to one crop. Moisture studies will be made at regular intervals.

Crops for Erosion-Resistant Strips: Small grain and sorghum sown broadcast are the most promising cultivated crops common to the Blackland region for use as the erosion resisting strip in a strip-cropping system. On the north one-half of Field Q, the slope of land is about three per cent, the length of slope is 800 feet, and the length of rows is 600 feet. Corn, cotton, and sorghum will be planted in strips 36 feet wide. The crops will be in a three-year rotation and the sorghum in this treatment will replace the oats as used on the south one-half of Field Q.

Soil Permeability and Soil Infiltration Studies: The field layout for this investigation will consist of a series of locations and treatments selected in the fields described under previously mentioned studies and other locations. Moisture samples will be taken periodically for each treatment under study and in connection with investigations using the rainfall simulator. The rainfall simulator will be used to determine the rate and amount of infiltration water into soils for the different treatments or conditions under study. These will include the following: cultural practices, deep tillage, crop rotation, type of cover, slope, soil type, degree of erosion, and incorporation of organic matter in the form of green manure, crop residue, barnyard manure, etc.

Supplementary laboratory studies of cause and effect relationships will be carried out with a view to determining the factors influencing the absorption of precipitation by the soil. Pot experiments will be conducted using not less than six replications to determine the utilization of water by different crops and the influence of these crops on the potential water storage capacity of the soils.

Many of the phases of this study are seasonal and will be undertaken as seasonal conditions and activities permit.

H. O. Hill.

Agronomic Studies

In the general crop and soil experiments conducted on the station an attempt is made to furnish not only the basic information upon which the cotton root rot and soil and water conservation investigations are predicated but also to supplement these specialized studies in such a way as to complete a well balanced research program on crops and soils for the Blackland region. The work specifically treated in this section is only that part of the field work for which a progress report is justified at this time.

Cotton Variety Test: A variety test of cotton has been conducted at this station since 1928. Of the 36 varieties grown in 1938, the highest yielding varieties in order of production are: Buckelew Mebane, 314 pounds lint cotton per acre; Mebane 804-50, 300 pounds; New Boykin, 296 pounds; Ferguson 406, 295 pounds; Rogers Acala, 288 pounds; and Chapman Ranch Mebane, 284 pounds. Only two varieties averaged as much as 300 pounds lint cotton in 1938; 7 ranged from 280 to 300 pounds; 14 ranged between 250 and 280 pounds; and 13 varieties fell below an average of 250 pounds lint to as low as 212 pounds per acre for Shafter Acala 8.

In a survey of the yields of the cotton varieties over the past ten-year period of the test, 11 varieties which have been grown each year are taken as the standards, and an average of their yields for the entire period is used as a basis on which comparable yields for all other varieties have been computed. The average yield of the standard varieties for the ten-year period is 268 pounds lint per acre, and the averages of the leading varieties in ranking order as to yield on a comparable basis are as follows: Rogers Acala, 313 pounds; Watson, 305 pounds; and Buckelew Mebane, 304 pounds lint cotton per acre.

Staple length for the different varieties for the ten-year period has ranged from as high as 1-3/32 inches for D. & P. L. 11A, to as low as 26/32 inch for Half and Half.

Corn Variety and Hybrid Test: A corn variety test has been conducted at this station since 1928. In 1938 this test included 14 commercial varieties and 50 strains of hybrid corn. The leading commercial varieties in ranking order as to yield are: Nelson's Native Yellow, 41.9 bushels shelled corn per acre; Reese Drouth Resister, 41.0 bushels; Ferguson Yellow Dent, 40.3 bushels; Ferguson Surcropper, 40.2 bushels; and Nicholson's Giant Yellow Dent, 39.8 bushels. During the past ten years, five commercial varieties have been grown each year and the average of all five for the period of years, 33.2 bushels shelled corn per acre, is taken as the basis on which comparable yields are figured. The leading varieties in the corn test for the period of years on a comparable basis are: Blankenmeyer's White Dent, 35.1 bushels; Reese Drouth Resister, 34.7 bushels; Nelson's Native Yellow, 34.9 bushels; Ferguson Surcropper, 34.5 bushels; Ferguson Yellow Dent, 33.2 bushels.

The most productive hybrid strain tested in 1938 was Yellow Surcopper x 132A, with a yield of 53.8 bushels, while the lowest producing strain was 3508-67 x Yellow Surcopper with a yield of only 28.8 bushels. Although the work in testing the productivity and miscellaneous characteristics of the various hybrid strains is relatively new at this station, the results so far indicate the promising importance of the hybrid strains in their ability to produce much higher yields than the leading commercial varieties.

Sorghum Variety Test: The sorghum variety test has been conducted on this station since 1928. This year the test consisted of 12 varieties, eight of which had never been tested at this station before. In 1938 five varieties produced in excess of 25 bushels threshed grain per acre, while seven fell below this average. The leading varieties in ranking order as to yield of threshed grain are as follows: Quadroon, 39.2 bushels per acre; Ch'ltex, 30.4 bushels; Dwarf Yellow Milo (Susceptible strain), 26.6 bushels. In forage production Leoti led with 4.54 tons dry forage per acre; this was followed by quadroon, 3.31 tons; Darso, 2.99 tons; Milo x Kafir x Sooner Milo, 2.83 tons. Over a seven-year period, two varieties which have been grown each year are used as the standards on which to base the comparable yields of the other varieties included in the test for periods less than seven years. The average of the standards for the period of years is 28.2 bushels threshed grain per acre and 3.06 tons dry forage per acre. On the basis of comparable yields, Quadroon, a new strain in 1938, ranked first in grain production with an average of 41.3 bushels, while African Millet ranked first in forage production with an average yield of 4.65 tons dry forage per acre.

Test of Disease Resistant Darso: In 1938 a comparative test of the susceptible and resistant strains of Darso was planted to determine the value of the milo-disease resistant characteristic in Darso seed. Darso from the susceptible seed was killed out within 30 days after planting, while the plots planted to the new disease-resistant variety, now known as Darso No. 28, produced an average of 33.5 bushels threshed grain per acre and 3.18 tons dry forage per acre.

Small Grain Rust Resistance Test: The small grain improvement work conducted at the Temple Station in 1938 consisted of testing 44 various strains of oats, 44 strains of wheat, and 11 strains of barley for rust resistance, as reflected in the yields.

The leading varieties of oats in this test in 1938 are as follows: Nortex x Victoria M19-7, 74.4 bushels threshed grain per acre; Kanota x Victoria 13-33-70, 71.0 bushels; Alber x R. R. P. 518 M3-3, 68.6 bushels; Nortex x Victoria M19-19, 68.2 bushels; Nortex x Victoria M19-17, 66.3 bushels; Nortex x Victoria M19-46, 66.0 bushels; and Bond x Alber M1-13, 64.8 bushels grain per acre. Seed from these leading strains will be kept and planted for increase next year.

Yields in the rust resistance test of wheat ranged from 33.32 bushels for Selection 41-121, 27.30 bushels for Selection 41-27-3-2, and 25.52 bushels for Selection 41-16-3-3, selections which were practically free from stem rust, to as low as 2.12 bushels per acre for Mediterranean 63, which was badly infected with black stem rust.

Barley yields in 1938 were only fair, the highest yields being given by the following varieties: Harlan Hybrid 1-32-103, 31.50 bushels threshed grain per acre; Harlan Hybrid 1-33-179, 29.05 bushels; Tennessee Winter, 24.0 bushels; and Harlan Hybrid 1-33-7, 22.85 bushels. Practically all of the barley varieties were attacked by a disease identified as leaf stripe.

Small Grain Date of Planting Test: In 1938 a test was made to determine the best date for planting wheat as revealed by data secured from plantings made on three different dates, namely: October 21, November 15, and February 8. Durum wheat was used and three replications were made of each planting. The November planting yielded both more grain and more straw than either of the other plantings, with an average of 2.53 tons straw per acre and 22.9 bushels threshed grain per acre. This test will be continued to secure reliable data over a period of years.

Oats Winter Hardiness Test: A winter hardiness test of oats was conducted at this station in cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C. Thirty strains were tested with germination percentages ranging from 97.0 per cent for Lee to 59.6 per cent for Coker's Fulgrain No. 2. There was no apparent loss this year from winter killing due to very mild weather conditions.

C. H. McDowell.

Analysis of Seed from Different Cotton Varieties Planted in 1938: Analyses were made of seed from 14 different varieties of cotton showing extremes in maturity, boll size, lint per cent, staple length, and yield. Protein content varied from a low of 19.00 per cent for Ferguson 406 to a high of 22.69 per cent for Half and Half. Oil content varied from a low of 15.50 per cent for Lankart to a high of 18.43 per cent for Sunshine. Variations in maturity, boll size, lint per cent, staple length, and lint yield had no effect on protein, oil, and moisture content of seed.

Cotton Seed Treatment Tests: Sulphuric acid delinted seed and Ceresan treated seed were compared with untreated seed for three different planting dates: April 1, April 19, and May 2. Germination was approximately twice as great in the treated seed as in the untreated seed for all planting dates. Seedlings from Ceresan treated seed had approximately one-third the amount of infection (bacterial blight and sore-shin) as untreated seed for all planting dates. Seedlings from delinted seed had approximately one-third the infection in the earliest planting date as untreated seed and about half the amount of infection as untreated seed for the two last planting dates. Yields of lint from treated seed were approxi-

mately 10 per cent higher than yields from untreated seed. Ceresan treated seed gave somewhat better results in this respect than delinted seed. Root rot was somewhat higher in treated seed than in untreated seed. This was probably due to the fact that plants from treated seed were much larger during the early part of the growing season than plants from untreated seed.

Ceresan (2 per cent) and New Improved Ceresan (5 per cent) were compared in a separate test. Results were similar from both treatments. Seedling infection was six per cent; root rot approximately 40 per cent; and yields approximately 500 pounds seed cotton per acre.

Yields of Winter Vegetables for Possible Use as Winter Cover Crops and Green Manure: Lack of a suitable winter legume for winter cover crop and green manure in the root rot control program suggested the use of winter crops commonly grown as vegetables. Cowhorn, Shogoin, and Seven-top turnips, Large Smooth-leaf, Florida Broadleaf, and Southern Giant Curled mustard, Georgia collard, and Dwarf Essex rape were selected for this purpose.

Green yields per acre varied from a low of 2,750 pounds for Cowhorn turnip to a high of 16,239 pounds for Large Smooth-leaf mustard. Dry weights were 296 pounds and 1,815 pounds per acre respectively for these two crops.

Control of Tievines by Chemical Sprays: Tievines were controlled by the use of either 100 or 200 pounds per acre of sodium chlorate applied as a spray (1 pound per gallon of water) at the late blossoming stage in the fall and in the spring about the time the plants have runners a few inches long.

C. H. Rogers.

Cropping Systems

In 1938 ten different rotations were studied at this station, four being three-year rotations, four being two-year rotations, and two being three-year rotations with a green manure crop. The rotations including a green manure crop were initiated this year, whereas all the others have been in practice for the 11-year period 1928 to 1938 inclusive.

Cotton in Rotations: Cotton appears in all rotations under study. The highest cotton yield for 1938 was secured from a two-year rotation consisting of cotton-corn, which produced an average yield of 346 pounds lint cotton per acre, as compared to the average yield of 306 pounds lint cotton per acre on the continuous check acre.

In the period of years' survey for 1928 to 1938 inclusive the results of the rotations as to cotton production show the rotation of cotton-corn ranking first with an average of 285 pounds lint cotton per acre. Of the four three-year rotations, the rotation consisting of cotton-sorghum-oats led with an average yield of 261 pounds per acre. The permanent check plots

on acre F-6 ranged in production from an average of 165 to 266 pounds per acre for the entire period, the average production of all check plats being 235 pounds lint cotton per acre.

Corn in Rotations: Corn appears in two rotations on the station farm. In 1938 the two-year rotation of cotton-corn yielded 41.5 bushels shelled corn per acre, while the three-year rotation of cotton-corn-oats yielded 35.3 bushels per acre. This is compared to an average yield for the permanent check plots of 39.6 bushels per acre. In a period of years' survey of the results of corn production in the rotation studies it is found that the two-year rotation of cotton-corn has yielded an average of 35.1 bushels shelled corn per acre for the 11-year period of the test, while the three-year rotation, cotton-corn-oats has yielded 28.6 bushels shelled corn per acre for the same period. The permanent check corn plots have averaged 28.2 bushels for the period of years.

Sorghum in Rotation: Sorghum was grown in a rotation of cotton-sorghum-oats and in a rotation of cotton-sorghum. In 1938 the three-year rotation averaged 8.58 bushels threshed grain and 2.65 tons dry forage per acre, while the two-year rotation yielded only 4.49 bushels threshed grain and 2.37 tons dry forage per acre. This is compared to 6.13 bushels threshed grain and 3.30 tons dry forage per acre for the continuous sorghum plats. Over the period of years of the test, the three-year rotation has surpassed the two-year rotation in production of both grain and forage with an average production of 32.4 bushels threshed grain and 3.22 tons dry forage per acre as compared to the average yield of 27.5 bushels grain and 2.70 tons dry forage for the two-year rotation and to the permanent check average yield of 22.0 bushels grain and 2.68 tons dry forage for the period of years.

Oats in Rotation: In 1938 oats was grown in three three-year rotations and in one two-year rotation. The highest production of both grain and straw was given by the three-year rotation of cotton-cotton-oats, which yielded an average of 55.04 bushels threshed grain and 1.98 tons straw per acre. The average production for the check plats in 1938 was 40 bushels grain and 1.40 tons straw per acre. In the period of years (1929 to 1938) the rotation of cotton-cotton-oats has led all cropping systems in production of oats, with respect to both threshed grain and straw, the average yield of this rotation being 43.3 bushels threshed grain per acre and 1.46 tons straw per acre. Rotation of cotton-oats ranks second in production of grain with an average of 37.8 bushels per acre. The period of years average of the permanent check plots of oats was 36.2 bushels threshed grain and 1.36 tons straw per acre.

Rotations with Green Manure Crop: In 1938 two three-year rotations were initiated on the contour plots for the purpose of studying the effect in reducing root rot, with cowpeas and sorghum broadcast on oat stubble and plowed under as green manure. Inasmuch as this is the first year of these rotations, yields this year serve as indicator crops rather than

as the results of rotation or green manuring practices. Cotton yielded 267 pounds lint per acre on both rotations, with 278 pounds on the East check plat and 307 pounds on the West check plat. The corn yield on the East rotation was 31.6 bushels shelled corn per acre, and the yield on the West rotation was 32.7 bushels shelled corn per acre. Oats yields were: 20.4 bushels threshed grain on the East rotation, and 30.2 bushels threshed grain on the West rotation. Cowpeas turned under as green manure following oats on the East rotation averaged 2.4 tons per acre green weight, while sorghum plowed under following oats on the West rotation averaged 5.4 tons green weight per acre.

C. H. McDowell.

Cotton Root Rot in Rotations: Cotton root rot in all rotations except two was less in 1938 than in continuous cotton check plots. Root rot varied from a low of 15.2 per cent in the two-year rotation of cotton-guar to a high of 63.4 per cent in the three-year rotation of cotton-corghum-oats. The average for these same areas during the period of 1928 to 1938, inclusive, was 51.6 per cent root rot for the cotton-guar rotation and 57.5 per cent for the cotton-sorghum-oats rotation. There was 56.0 per cent root rot in continuous cotton in 1938 compared to 65.9 per cent root rot for the 1928-38 period of years average. For the 1928-38 period a three-year rotation of cotton-corn-oats has shown an average root rot kill of 40.5 per cent compared to a kill of 57.5 per cent in the three-year rotation of cotton-corghum-oats. Cotton root rot percentages in the two-year rotations for 1938 and for the 1928-38 period, respectively, are as follows: cotton-oats, 53 and 57 per cent; cotton-sorghum, 36.8 and 67.8 per cent; cotton-guar, 15.2 and 51.6 per cent; and cotton-corn, 19.7 and 53.2 per cent. There has been a higher average yield of both cotton and grain in the two-year rotation of cotton-corn than in any other rotation on the station farm. It appears that those combinations wherein corn appears, especially where followed by cotton, give higher yields and serve better to reduce the infestation of cotton root rot.

C. H. Rogers.

Plant Introductions

A total of 251 plants representing 34 species were introduced in 1938 from the Division of Plant Exploration and Introduction, Bureau of Plant Industry, U. S. Department of Agriculture. All of these plants were received in February or March. The late winter and early spring was dry and windy, followed by a late freeze on April 8. These conditions together with root rot eliminated over half of the plants. On December 16, 1938, a total of 101 plants survived. Attempts were made to select plants that would prove of ornamental value or of value for use in preventing erosion.

C. H. Rogers.

Plant Diseases and Insects Observations

Miscellaneous Plant Diseases: Bacterial blight (*Bacterium malvacearum*) and sore-shin (*Corticium vagum*) were unusually severe on cotton seedlings this year due to the continued cool, wet weather in the late spring. Boll rot infections occurred in the late season, especially where the bolls had been injured by boll worm. Little or no bacterial blight occurred in the latter part of the season. Due to the dry summer and early fall, chlorosis on a number of ornamentals, field, and vegetable crops was unusually severe. Peaches, plums, Amur privet, arborvitae, and cowpeas suffered considerably. Mildew on cucurbits, crape myrtle, coral berry, lilac, and a few other plants was comparatively heavy. Outbreaks and infections of black stem rust occurring in small grain this year, especially in wheat, were much more severe than usual. A list of plant diseases for 1938 has been compiled for the Plant Disease Survey.

Insect Pests: There was an exceptionally heavy infestation of lice on cotton, plums, arborvitae, cucurbits, pecans, and a few other crops during the spring and early summer of 1938. The lice together with bacterial blight caused severe defoliation of cotton seedlings in almost all fields in Central Texas, especially where seed were not treated. Infestations of bag worms on shade trees and of flea hoppers, boll worms, and leaf worms on cotton were severe during the 1938 growing season. Heavy infestations of sorghum web worm occurred in three or four fields. Other insects showing unusual activity were grubs, fleas, termites, and other household insects.

C. H. Rogers.

Livestock Investigations

With the recent movement toward crop diversification and reduction, soil conservation, and improvement of soil fertility, livestock goes hand in hand with the new era in agriculture, and this fact is justification for the adoption of a well balanced livestock program for the future farming interests of the South and Southwest. In line with this new movement, the station feels justified in adding a rather extensive livestock program as one of its important activities.

Sheep: A small flock of sheep consisting of approximately 135 head of grade range Rambouillet ewes are maintained at this station to utilize the 34 acres of pasture land bordering on Boggy Creek. Accounting for rather heavy losses during the year from dogs, diseases, and natural causes, the station flock has produced a net return in a 12 months period of approximately \$400.00, which is about 60 per cent of the total purchase price.

Cattle: On October 17, 1938, twenty head of good choice grade Hereford steer calves were purchased for the purpose of utilizing the surplus feed grown on substation land. These calves were put on feed November 14 and will be fattened.

Hogs: On account of the large amount of corn and other grains produced on the substation in 1938 and due to the low market prices of feed, early in October 63 head of shoats and stocker pigs were purchased locally for the purpose of feeding out the station surplus crop of corn.

C. H. McDowell.

SUBSTATION NO. 6, DENTON

Substation No. 6, five and one-half miles northwest of Denton, is 600 feet above sea level. The average annual rainfall for a period of 26 years is 32.50 inches, 21 per cent falling in December, January, February; 32 per cent in March, April, May; 23 per cent in June, July, August; and 24 per cent in September, October and November. The average dates of the last killing frost in the spring and the first in the fall are March 25 and November 13, respectively. This station is in the important wheat and oat producing area of North Texas. The predominating soils are clays of the San Saba and Denton series, which are typically developed on the Fort Worth Prairie, the northern part of the Grand Prairie Region. The station comprises an area of 209.92 acres.

A large part of the work of this station is devoted to the breeding and improvement of small grains for the wheat, oat and barley growing regions of Texas. However, considerable time and effort are devoted to the growing and improvement of other field crops adapted to north Texas conditions and to experiments with pasture and soil improvement crops.

Small Grain Investigations

(In cooperation with the Bureau of Plant Industry, U. S. D. A.)

The breeding work with small grains is designed to test progeny of numerous crosses made at this station and those received from other research workers in comparison with the standard commercial varieties. After strains have become stable in their characters and have shown superior performance in preliminary tests they are grown in replicated field plats to obtain additional and more accurate information on resistance to rusts, smuts, shattering, lodging, drouth and cold, as well as quality and yielding ability.

The 1937-38 growing season for small grains was abnormal in many respects. The crop was planted under very favorable conditions and made very excellent growth during the months of October, November and December. Temperatures above normal and excessive rainfall during the months of January, February and March retarded growth and caused considerable yellowing of the plants. A sudden drop in temperature on April 7, with freezing temperatures on the 8th, 9th and 10th, injured all small grains, particularly the early varieties that were in the boot or first head stages. However, favorable temperatures following this freeze permitted rapid recovery, and heading dates were from 10 days to two weeks earlier

than normal. Very favorable growing conditions during May tended to lengthen the filling period and, as a result, all small grains matured near their normal dates.

Leaf rust of wheat appeared late in February and spread rapidly. By April 1, all susceptible varieties, such as Turkey wheat, showed 90 to 98 per cent infection and severe stunting of growth. Stem rust appeared on April 22, more than two weeks early, but cool temperatures prevented rapid spread and only late maturing susceptible varieties were seriously damaged. Hot weather, the first week in June, caused rapid spread of both crown and stem rusts of oats, and spring planted oats were seriously injured. In addition to these diseases, a heavy and early infestation of army worms did considerable damage before poisoning and natural parasites brought them under control. A severe infestation of stem maggots in wheat was responsible for some reduction in yield.

Wheat: Yields obtained in the variety test this year were higher than expected considering the adverse conditions under which the crop was grown. The leading variety was the new smut resistant Oro x Tenmarq strain, yielding 22.1 bushels, with a test weight of 58 pounds. Other varieties that yielded exceptionally well this year included two strains of Kawvale x Tenmarq, one strain of Martin x Tenmarq and Early Blackhull. Clarkan was again the leading soft wheat variety. Of the varieties grown for a period of 3 years or longer, Quivira and Tenmarq continue in the lead. For a period of 10 years, Tenmarq has averaged 30.3 bushels per acre, or 4 bushels more than the average yield of the standard commercial varieties. Because of its excellent performance in tests at this station, as well as in experimental tests at Greenville, Chillicothe and Amarillo, Tenmarq is recommended above all other varieties for the wheat ares of north and northwest Texas.

Cooperative Wheat Variety Tests: Cooperative winter wheat variety tests have been conducted in the Texas Panhandle since 1931. Also, all promising strains and varieties of wheat, oats and barley developed in preliminary tests at Denton are also tested on land near Amarillo, Texas, where the conditions of that region might reveal advantageous factors, such as resistance to cold and drouth. A summary of all tests for all the years grown shows that Tenmarq, Clark's Blackhull, Kanred, Kawvale, Cheyenne and Chiefkan are about equal in production, all averaging between 13 and 14 bushels per acre. Since Tenmarq is superior to the other varieties in milling quality, it probably should be given preference by wheat growers in the Panhandle area.

Diseases of Wheat: The two principal diseases of wheat in north Texas are leaf rust and stem rust. Leaf rust is present nearly every year from March until the crop is matured, and the damage over a period of years probably exceeds the average damage from stem rust. Breeding for resistance is the only practical means of control. Definite progress through hybridization and selection has been made, and it is believed that within

a few years strains combining immunity or high resistance to this rust, with other desirable characters, will be available for distribution to growers.

Stem rust of wheat is present nearly every season in north Texas, doing damage in proportion to the earliness of infection and the favorableness of temperature and moisture conditions. Since this fungus disease overwinters on wheat and some grasses in south and central Texas and moves northward with south winds in late spring, the problem of breeding resistant wheats for this area is of national importance. Very satisfactory progress in breeding wheats resistant to this rust is being made, even though there are many complicating factors.

Loose smut of wheat has become an important fungus disease in recent years. Spores of this fungus are carried by wind and infect healthy grains of wheat when in the milk or earlier stages of development. Since the infection is carried within the seed, the only available methods of control are treating with hot water or breeding for resistance. It is expected that the breeding work now in progress at this station eventually will combine resistance to this disease with the other characters necessary for consistently high production.

Oats: A selection of Texas Red Rustproof, T. S. No. 1415-12, with a yield of 98.7 bushels per acre was the leading variety in the regular fall planted variety test this year. Two strains of Nortex x Victoria and one strain of Fulghum x Victoria made the next highest yields of 97.0, 95.6 and 96.1 bushels per acre respectively. These new strains are highly resistant to crown rust and smut. The Fulghum x Victoria strain is especially promising due to its strong straw and ability to stand long after harvest.

During the period of years, 1926 to 1938, Nortex, New Nortex, Ferguson 922 and Texas Red Rustproof 1118-69 have been in the fall variety test each year. During this period, New Nortex averaged 79.6 bushels per acre, which is approximately five bushels more than Nortex and seven bushels more than Ferguson 922. Distribution of New Nortex was started in the fall of 1937, and a good supply of seed is now available.

In the spring planted variety test, Nortex, New Nortex, Ferguson 922, Texas Red Rustproof 1118-69 and Frazier (Fulghum) have been grown each year for the period 1930 to 1938. During this period, New Nortex made an average yield of 77.2 bushels, which is only slightly above that of the other three red rustproof varieties. Frazier, a strain of Fulghum, developed by this station, made an average yield of 69.4, or about eight bushels less than the red rustproof varieties. The new strains of Nortex x Victoria and Fulghum x Victoria were included in this test, and made very excellent yields.

Crown rust, stem rust and the smuts are important diseases of oats in Texas. Rapid progress is being made toward producing a red oat for

Texas farmers which will be resistant to all these diseases and, therefore, more productive.

Barley: Excellent yields of good quality grain were produced by practically all varieties in the fall planted variety test this year. Wintex barley (formerly listed as Smith S-31-62) was again the outstanding variety, with an average yield of 58.5 bushels per acre. Yields of the other varieties ranged from 40.8 to 49.7 bushels per acre. During the three years that Wintex barley has been in the regular variety test, it has averaged 52.5 bushels per acre, or about 10 bushels more than the next best variety. Distribution of Wintex barley to farmers was started on a small scale in the fall of 1937, and there should be a good supply of seed available by the fall of 1939.

Twenty-three barley varieties and strains were included in the spring-planted variety test. Because of excessive moisture in February and March, mildew and leaf blotch caused considerable damage to the plants. Fairly good yields were made, but the quality of the grain was poor. Stavropol, a spring type, made the highest average yield of 44.7 bushels per acre. The intermediate or semi-winter type barleys, such as Wintex, Finley, etc., were injured very severely by leaf blotch, and made very low yields. The true winter types, such as Tennessee Winter and Missouri Early Beardless, were not included in this test because previous tests had proved they would not produce satisfactorily when spring-planted. In general, only strictly spring-type varieties should be planted in the spring, but the intermediate types, such as Wintex or Finley, may be planted if seed of the spring varieties is not available. The true winter types should never be spring-planted; neither should the spring types be fall-planted because they are easily winter-killed.

Flax: Since 1931 six varieties of flax have been included in a variety test planted at early, medium and late dates in the spring. The average yield of all varieties at the early date (March 10) is 12.8 bushels, as compared with 11.0 bushels at the medium date (March 20) and 5.6 bushels for the late date (April 1). North Dakota No. 114, Rosequin and Linota are the leading varieties and are about equal in production. None of the varieties tested is sufficiently winter hardy to be fall-planted.

I. M. Atkins, Bur. Pl. Ind., and P. B. Dunkle.

Corn Varieties and Hybrids

This year, 54 first year hybrids, each having Yellow Surcrotter as one parent and an inbred strain of either Yellow Dent or Surcrotter as the other parent, were planted in comparison with 10 standard commercial varieties. Approximately one-half of the hybrid strains yielded from one to five bushels more than the average of the 10 commercial varieties, which is less than expected but, nevertheless, sufficient to indicate inherited yielding ability in each of the inbred strains involved in the hybrids. One of the objects of this test and previous similar tests is to discover a few

superior inbred strains of either Yellow Dent or Surcropper so that the best possible combination of inbred strains may be made to produce highly productive single or double crosses for commercial corn production in this region. So far, in the corn breeding work at this station, none of the hybrids of inbred strains has been sufficiently productive to justify its use in commercial production. Very vigorous growth of corn hybrids makes them very susceptible to drouth and hot winds, which often occur in this area about tasseling time early in June.

The yields in bushels per acre of the 10 commercial varieties were as follows: Blankemyer White Dent, 33.0; Multisure, 32.4; Denco Yellow Dent, 30.2; Red June, 30.0; Surcropper, 30.0; Golden June, 29.8; Skiles Yellow Dent, 29.3; Ferguson Yellow Dent, 27.9; Yellow Surcropper, 27.7, and Mexican June, 26.3. Only five of the commercial varieties have been included in the test each of the 10 years, 1929 to 1938. Their 10-year average yields are: Surcropper, 27.9; Reese's Drouth Resister, 26.2; Denco Yellow Dent, 25.7; Blankemyer White Dent, 25.6; and Ferguson Yellow Dent, 24.4.

Corn versus Grain Sorghums

Four varieties of grain sorghum, Darso, Hegari, Chiltex and Ajax, have been grown in direct comparison with Surcropper corn each of the 11 years, 1928 to 1938. During this period, the average yield of grain in bushels per acre is 35.6 for Chiltex, 32.9 for Darso, 28.7 for Ajax, 25.0 for Hegari and 25.6 for Surcropper corn. The failure of Hegari to head in the dry weather of 1936 accounts for its low average yield. The average yields for the last seven years are: 44.0 for Chiltex, 37.8 for Darso, 33.5 for Ajax, 22.2 for Hegari and 27.0 for Surcropper corn. The high average yield of Chiltex is largely due to the exceptionally high yields made in 1937 and 1938.

In tons dry forage per acre for the period 1932 to 1938, Hegari produced 4.13; Darso, 3.75; Ajax, 3.43; and Chiltex, 3.28.

Because of the slightly higher production of grain and the value of the forage produced by the grain sorghums, it is believed that the live-stock farmer in North Texas would profit by making greater use of grain sorghums.

Effect of Grain Sorghum and Corn upon Succeeding Crops

Since 1933 a study has been made of the influence of sorghum varieties and corn on the yield of oats, wheat, barley, corn, cotton and cowpeas. The entire stalk of corn and the stubble of the sorghum varieties are plowed under about September 1 and the above named crops planted at their normal dates. In general, the average yields indicate that the deleterious effect of the grain sorghums does not last longer than about June 1. Apparently the duration of the effect depends upon soil moisture and temperature conditions and the activity of micro-organisms, which break down the sorghum residue in the soil. Fall planted wheat and

barley and spring planted oats are reduced in yield from 10 to 15 per cent, whereas, corn is affected very little and cotton and cowpeas are not damaged at all. This experiment is important to farmers in that it is clearly shown that they need only to plow under their sorghum residue as early in the fall as possible and then follow with such late spring crops as cotton, sorghum, cowpeas, etc..

Cotton

Summary of six replications of randomized plats of 18 varieties of cotton planted this season shows Bryant Mebane leading with a yield of 269 pounds lint per acre. Next in order were New Boykin, 265; Qualla, 258; Ferguson 406, 256; Harper, 249; and Sunshine Selection 83-3, 246. The lowest yield of 218 was made by Half and Half. The staple length of all varieties was exceptionally good this year. Half and Half measured $\frac{7}{8}$, Acala, $1\frac{1}{8}$, and all other varieties, $1\frac{1}{32}$ inches. In the period of years 1929 to 1938, Sunshine Selection 74-2 averaged 291 pounds lint per acre, Sunshine Selection 83-3, 285; Half and Half, 284; Watson, 281; Cliett, 278; Ferguson 406, 272. D. & P. L. 11A made the lowest yield of 187. At present prices for staple lengths above one inch, Acala, with an average yield of 259 pounds and staple length of $1\frac{1}{8}$ inch, likely would be the most profitable variety to grow on the heavier black lands of this region.

Cotton Breeding: Twenty-eight inbred lines of Sunshine cotton, T. S. No. 10104, were planted again this year for the purpose of studying the effect of inbreeding on the general uniformity of plant characters, staple length and yield. From this breeding work have come two exceptionally good strains, selections 74-2 and 83-3, both of which are in the lead in the regular variety test as well as in this breeding test over a period of four years. In addition to superior yield, both are superior in storm resistance and lint per cent to the parent Sunshine from which they were first selected in 1929. Both have been increased, and a small amount of seed is now available for distribution to farmers.

Wide Row Spacing of Cotton: Cotton planted in single rows six feet apart and in plats with every third row vacant was compared with cotton planted in every row in the usual manner. The number of plants per acre was the same for all methods of planting. The average yield of lint was 231 pounds for the rows six feet apart, 218 for the two-row-skip-one method and 215 pounds for the regular method of planting. Since this is the first year of this test, the results indicate only that wide row spacing of cotton may be advantageous under conditions very similar to those prevailing this year.

Legumes

Because of very low forage production, due to soil and climatic conditions, of many legumes previously tested, the legume variety test this year

included only those varieties which have shown considerable promise for forage, pasture, or soil improvement. For fall planting and use for pasture and soil improvement, only the bur clovers and Black Medic can be expected to give satisfactory results. Hairy vetch and Austrian Winter peas continue to be the most promising winter legumes for hay and soil improvement. Neither of these legumes makes sufficient growth in late fall or winter to furnish much grazing. Sweet clover is the outstanding legume for general purpose use on the black upland of this region. The biennial white variety is the best and most commonly used for hay, pasture or soil building. Hubam, the annual white variety, makes more rapid growth than the biennial and, therefore, should be used on land infected with cotton root rot disease. This variety ordinarily reaches maximum growth and matures some seed before the soil is warm enough for the root rot to develop. Alfalfa is about equal to sweet clover in forage production during the first two or three years of growth; after this time, subsoil moisture is so depleted that the plants cannot make satisfactory growth on moisture provided by average annual rainfall. The Common variety of alfalfa has proved more productive than the other varieties tested. For the period of years, 1932 to 1938, the yields in tons dry forage per acre are 1.73 for Common alfalfa (1st year), 1.52 for biennial white sweet clover (1st year), 1.38 for Black Medic, 1.38 for Hairy vetch, 1.27 for bur clover, 1.16 for Hubam and 1.00 for Austrian Winter peas.

Sweet Clover Method of Planting Test: During the period 1933 to 1938, the first year growth of biennial white sweet clover, planted with a grain drill at the rate of 15 pounds per acre, has averaged .98 ton dry forage per acre as compared with .88 when planted in 18-inch rows and .72 when planted in 36-inch rows. For pasture and soil building purposes, 18-inch or 36-inch rows should prove the most satisfactory to the farmer on the black upland of this region. When the sweet clover is planted in spring oats by either of the above methods, the yield of oats is slightly reduced and the sweet clover does not make sufficient growth following harvest of the oats to be of much value that year. However, the second-year growth is about the same as that not planted in oats as a nurse crop.

Soy Beans

Variety Test: Mammoth Yellow, Laredo and Ootootan have been in tests at this station each year since 1923, but since 1936 15 varieties have been included. The leading varieties in forage production for the past three years are Easy Cook, Laredo, Avoyelles, Delnoshat, Palmetto, Ootootan and Mamredo, with yields of 1.08, .95, .94, .90, .89, .86 and .86 tons per acre, respectively. The Laredo variety is to be preferred for ordinary farm production because it is less palatable to rabbits and produces a high quality forage.

No variety in the tests has produced satisfactory yields of seed, probably because of the high temperatures that usually prevail during the

blooming period in July and August. In 1936, the seed yields ranged from a low of 41 pounds per acre to a high of 746 pounds per acre. In 1937, Manchu, an early maturing variety, made a yield of 323 pounds, while all other varieties failed completely. In 1938, Manchu and Virginia, early maturing varieties, made yields of 1113 and 678 pounds per acre, respectively. All other varieties failed completely.

Date of Planting: All varieties were planted at three different dates in the spring; the early date, about March 20; the medium date, April 20; and the late date, May 20. Forage and seed production were not greatly influenced by the time of planting. About April 15 to 20 appears to be the optimum date.

Rate of Seeding and Inoculation: Inoculated and non-inoculated seed of the Mamloxi variety were planted at 20, 30, 40 and 50 pound rates during the three-year period, 1936 to 1938. The average yields of forage show that rate of planting has very little influence on production, although slightly in favor of a rate between 20 and 30 pounds. The effect of inoculation was not apparent or measurable in any of the three years of the test; neither were differences noted in the number and size of nodules on the roots.

Crop Rotation Studies

Cotton Rotations: The influence of 10 different types of crop rotation on the production of cotton as compared with cotton grown continuously on the same land has been recorded each year since 1931. While the average yields of cotton in the different rotations are not significantly different, they do indicate that rotation increases yield. Rotations, in which cowpeas or sweet clover are grown as an annual crop for hay and then plowed under, have made the highest yields of cotton. However, the use of sweet clover or cowpeas in the rotation has a tendency to increase cotton root rot infection in the soil unless two or more years of non-susceptible crops, such as corn and small grains, intervene between the susceptible crops. Winter legumes, such as Austrian Winter peas and Hairy vetch, have proved fairly satisfactory when planted in corn early in the fall and then were plowed under the next spring in time to prepare the ground for cotton. Rotation of cotton with corn or small grains is a common practice in this North Texas area, and the experiments thus far do not suggest a more profitable practice.

Corn Rotations: Corn also is grown in 10 different crop rotations in comparison with corn grown continuously on the same land. Production has not been greatly influenced by the type of rotation. Rotations, in which winter peas, vetch or oats were planted in the early fall and then were plowed under as green manure in time to plant corn, have increased the yield of corn slightly. Also, rotations in which sweet clover or cowpeas were planted as annual crops for forage and soil improvement have increased the yield of corn slightly. Other types of rotation have had little or no influence on yields of corn.

Wheat Rotation: Wheat, grown in a 4-year rotation with corn, oats, and sweet clover, averaged 26.2 bushels per acre, as compared with 24.8 bushels for wheat grown continuously on the same land.

Oats Rotations: The average yields of oats in four different rotations during the period, 1931 to 1938, ranged from 63.7 to 68.7 as compared with 59.9 for oats grown continuously on the same land. Planting sweet clover in oats in two of the rotations has reduced the yield of oats slightly below that of oats without interplanted clover. However, this method of planting sweet clover does not affect the vigor of the second year growth and is, therefore, an economical method of using sweet clover in the rotation.

Pasture Experiments

Very few of the grasses tested have proved satisfactory for either temporary or permanent pastures. Rescue grass and Italian rye grass have given good results when planted alone on cultivated land and when planted in native grass pasture for late winter and early spring grazing. Italian rye grass must be reseeded early in the fall each year for best results.

Buffalo and Bermuda grass appear to be the only grasses suitable for establishing permanent grass pastures on the black uplands of this area. Buffalo is the predominant grass in all native grass pastures in this region, and is preferable to Bermuda for establishing new permanent pasture. Since the seed of Buffalo is not easily harvested and is not yet available on the market, sodding is the only practical method of planting.

Results of an experiment to determine the relative amount of pasture provided by small grains and rye grass through the winter and early spring and to determine the effect on yields when grazing was stopped February 15, March 1 and March 15 have been published in Bulletin No. 539.

P. B. Dunkle.

SUBSTATION NO. 7, SPUR

Substation No. 7, Spur, is located one mile west of Spur, Dickens County, latitude 33 degrees north, longitude 100 degrees west, at an elevation of 2,274 feet above sea level. Spur is located on the Rolling Plains of Texas, being 14 miles east of the escarpment known as the Cap Rock, which forms the line of division between the High Plains and the Rolling Plains of West Texas. The average annual rainfall for 28 years is 21.00 inches with extremes of 11.09 inches and 38.08 inches. The average length of growing season is 214 days. The station comprises 413.9 acres, of which 380 acres are in cultivation and the remainder in native grass pastures. The soils consist of Abilene and Miles clay loams and are characteristic of a large portion of the soils of Northwest Texas.

The station is concerned with three principal lines of research: the development of profitable crop farming under conditions existing in the region; the utilization of feed crops grown in the section in the fattening of cattle and sheep; and the complete conservation and utilization of rainfall, including storm water from rough areas, in the production of cultivated and native plants.

Cotton Experiments

Varieties of Cotton: The low yields from the cotton variety test were largely caused by a shortage of moisture during late summer months. A heavy crop of flowers was produced but the subsequent shedding of fruit resulted in materially reduced yields. The highest yields were made by Burnett and D. & P. L. 11A, 138 pounds of lint cotton per acre each. Both of these varieties had 29/32-inch staple. Over a period of years the Mebane strains and Half and Half have been the higher and more dependable yielding varieties. The soil on which these tests have been conducted is Abilene clay loam, which in years of normal or sub-normal rainfall is a drouthy soil. The length of lint is therefore at a minimum for any variety in most years. On the sandier soils of the region, the varieties that produce untenderable staple on the station soils will generally produce staple of $\frac{7}{8}$ -inch or more.

Date of Planting Cotton: During 21 crop seasons plantings of cotton have been made at 10-day intervals from April 10 to July 10. The highest yield in 1938 was produced by the planting made on May 1. The optimum planting date has varied greatly with seasons, but as an average of the long-time period, plantings made at the middle of May have given the highest yield and the crops have been produced more economically than from earlier plantings.

Spacing of Cotton: In the cotton spacing test the distance between plants in 36-inch rows is increased by 3-inch intervals from 3 inches to 36 inches. In 1938 the highest yield, 250 pounds of lint cotton per acre, was produced by the 18-inch spacing. Over a period of 19 years the average yields from the spacings of 9 to 24 inches have differed only slightly, which indicates that the cotton plant readily adjusts itself to differences in spacing.

Method of Planting Cotton: In 1938 rows 36 inches wide with plants spaced 12 inches in the row gave a higher yield than 72-inch rows with 6-inch spacing or 36-inch rows with 9-inch spacing and every third row left fallow. During the seven years that the test has been in progress the 72-inch rows have given a slightly higher average yield. Where the same method of planting is used and the plants given the same spacing in the row, the yields have been increased as the area for each plant has increased.

Cotton Cultivation: Different plats of cotton are given from one to seven cultivations at intervals of two weeks. Seasonal conditions determine the number of cultivations needed for optimum plant growth. Generally, cultivations above the number needed to kill weed growth do not produce increases in yield and in most cases cause a decrease. The harmful effect of continued late cultivation is indicated by wilting of plants and the subsequent shedding of fruit as a result of destroying part of the widespread system of lateral roots. Through a period of 16 years an average of two cultivations each season has given the highest yield.

Grain Sorghum Experiments

Grain Sorghum Varieties: Twenty-seven varieties of grain sorghums were given grain yield trials in 1938. The highest yield, 52.2 bushels of grain per acre, was made by Finney milo. Club kafir and hegari were next in yield with 51.1 bushels and 48.1 bushels respectively. Over a period of years the more dependable yielders have been dwarf yellow milo, Texas blackhul kafir and Spur feterita.

Date of Planting Milo: The earlier plantings of milo made the higher yields in 1938. Sufficient rain fell in the spring to carry the earlier plantings to maturity, but later plantings were adversely affected by a shortage of moisture in late summer. The highest average yields during a period of 21 years have been made by planting in the latter part of May and the first part of June. The relative yields from the different planting dates have varied greatly from year to year and have been largely determined by the supply of soil moisture at fruiting time.

Spacing of Milo: The spacing of 21 inches between plants in 36-inch rows gave the highest yield in 1938, and the same spacing has given the highest average yield over a period of 16 years. The optimum spacing varies considerably from year to year, the closer spacings being desirable in years of high rainfall and the wider spacings in dry years.

Method of Planting Milo: As an average of 16 years, where the same number of plants per acre are used for each method, the difference in yield of dwarf yellow milo planted in 36-inch rows, 72-inch rows and paired 36-inch rows has not been significant. A practical and economical procedure is to plant all rows and then, when the plants are six to eight inches high, plow out every third row or every other row if the stand and soil moisture conditions warrant this.

Milo Cultivation: Two cultivations gave the highest yield in 1938 and have given the highest average yield during a period of 15 years. As was the case with the previously-discussed cotton cultivation test, cultivations of milo above the number required to keep down weed growth have not resulted in increased yields.

R. E. Dickson and B. C. Langley.

Soil and Water Conservation Studies

(In cooperation with Soil Conservation Service, U. S. D. A.)

The experiments at this station relate particularly to the Southern Great Plains area. This project has been under way for 13 years and has for its purpose the factors influencing run-off losses and soil erosion and the effect of water and soil conservation practices on crop production. The factors contributing to run-off and soil losses are studied on control plats 1/75-acre in area. The efficiency of different crops in preventing water and soil losses is studied on field areas varying in size from six to 120 acres.

Rainfall: The rainfall in 1938 was 19.96 inches, which is 1.04 inch below the 28-year mean. During the 13-year period that this study has been in progress the annual rainfall has been below the long-time mean nine years and above four years. The average for the 13 years, however, is only 0.33 inch below the average for 28 years. The rainfall during this period is therefore fairly characteristic of the amount and distribution that may be expected in this region. The extremes of yearly rainfall for the 13-year period are 38.08 inches in 1926 and 12.88 inches in 1934. The season of 1938 was characterized by comparatively heavy rainfall in the spring and a prolonged drouth period extending from July 22 to the end of the year, during which time the effective rainfall was negligible. During the first seven months of the year 88.7 per cent of the total yearly rainfall occurred. Torrential rains are a common occurrence in this region, and measures of water control are of vital importance in saving this much-needed water for use in crop production.

Control Plats: In 1938, 53.8 per cent of the rainfall causing run-off was torrential (.75 inch or more per hour), which is 6.5 per cent above the average for 13 years. A rain of 1.80 inches on July 21, 80 per cent of which was torrential, resulted in a loss of 78.3 per cent of the water from a fallow plat. Factors other than the intensity of rainfall play an important part in determining the extent of water and soil losses. These losses decrease as the amount of vegetative cover or litter increase. The following treatments are given in their order of effectiveness in preventing both water and soil losses: buffalo grass, milo, cotton, cultivated fallow, uncultivated fallow. The loss of water increases with increase in slope of land but run-off is not proportional to the increase in slope.

Field Areas: The idea of using the soil as a storage place for water that may later be used in crop production is one that is being extensively put into practice in the region. Seasonal rainfall, although it is a highly significant factor in determining crop yields, is not sufficient alone to produce normal yields. Preseasonal rainfall that has been stored in the soil is necessary to supplement the seasonal rainfall. Any conservation measure which increases this amount of water before planting operations begin reduces in proportion the hazard of short crops or crop failures.

The soils of the region as a general rule are sufficiently deep and porous to hold within the root zone of cultivated and range plants much more water than normally occurs as rainfall, but it is essential that some obstruction be used on most of the soils to retard the movement of water during heavy downpours so that it may have more time to penetrate into the soil.

Various conservation practices as put into effect on areas of six to 10 acres show that crop yields have been consistently increased as the amount of water available for plant use has increased. The effectiveness of certain measures of water control in reducing the loss of water from crop land and in increasing yields is shown by the following data which are an average for the period 1927-38:

	Inches water lost	Inches water added	Yield, lbs. lint cotton per acre
Rows with slope.....	2.22	.....	139
Contoured rows, no terraces.....	1.49	.....	167
Level terraces, ends closed.....	0	.....	197
Level terraces, ends closed, waste water added.....	0	2.96	233

Syrup-Pan Terrace System: For eight years the run-off water from a 1,200-acre watershed adjoining the station has been diverted on to a 120-acre tract of land that has a system of level terraces with alternate ends partly open for conducting the water back and forth across the field as it flows toward the lower end. During the period 20 rains have caused water to flow on to the tract, all of which have supplied enough water to flood the upper 56 acres. Only eight of these rains, however, have supplied enough water to flood the entire 120 acres. The water available for crop production has been increased 20.9 per cent on the upper 56 acres and 13.5 per cent on the lower 64 acres. In several of the years during the period this additional water has meant the difference between fair to excellent crops and crop failure.

One of the most interesting phases of this study is the cost of storing water in the soil in the syrup-pan system. Cost data on the construction of the dikes reveal that the storage place for an acre-foot of water has cost \$1.25. The cost of storing an acre-foot of water in large reservoirs ranges from \$10.00 to several hundred dollars, and the cost of lifting an acre-foot of water from irrigation wells in the region is approximately \$6.00. It appears that terraces such as those in this system are the cheapest from the standpoint of storing water of any practice in the region.

The chief aim of water conservation research at this station, therefore, is to develop a flexible system of water management on agricultural land that will reduce farming risks and tend to stabilize production through periods of deficient rainfall. This applies not only to years such

as 1934, when rainfall was below normal every month, but also to the mid-summer depression of rainfall which occurs over all parts of Texas in almost every year. An endeavor to store water in the soil when and where it falls and thus build up a reserve supply of soil moisture is one that pays large dividends on the time and effort expended.

Pasture Improvement Studies: The value and importance of soil and water conservation practices on native grassland has in recent years received serious consideration at the Spur Station. Severe droughts, along with overstocking in many cases, reduced the cover of native vegetation to the point where the grassland was no longer profitable for grazing. Over a period of years natural revegetation will overcome this condition, but if a good cover of grass is to be established within a relatively short time some assistance must be given which will make conditions more favorable for the growth and production of grass. Many practices have been evolved in an effort to revegetate badly deteriorated grassland, each being based upon some particular set of conditions.

Pasture improvement studies on native grassland include the use of such mechanical structures as solid listing on the contour, listing with alternate strips left unlisted, terracing, and diversion of run-off from roads. Other studies include eradication of mesquite, mowing of weeds, effect of shade on the quality of grass, reseeding of land not suitable for agricultural crops, and changes in the vegetation brought about by deferred grazing.

The vegetation on the station pasture before listing was predominantly buffalo grass (*Buchloe dactyloides*) with trace amounts of other short grasses. Many annual winter and spring weeds were also present. The area used in these experiments has a slope of 1 to 3 per cent and the soil type is Miles clay loam. The yield of vegetation from the unlisted blocks and from those solid listed to a depth of three inches at 39-inch intervals are given below.

Treatment	Yield, lbs. air-dry vegetation per acre				
	1935	1936	1937	1938	Average
Unlisted.....	858	592	259	810	630
Contour listed 1934.....	2,424	2,315	1,133	1,376	1,812
Contour listed 1936.....		1,326	2,159	1,973	1,819
Contour listed 1938.....				1,178	1,178

The maximum depth of moisture penetration during the growing season was 48 inches on contour listed grassland and only 18 inches on unlisted areas. The average supply of available moisture during the growing seasons of 1937 and 1938 was 1.25 inches on the unlisted grassland and 3.36 inches on contour listed areas.

Contour listing treatments have produced a marked change in the basal cover of grasses and weeds. The most striking change has been the

large increase in cover of buffalo grass accompanied by a very marked reduction in the cover of weeds. The basal cover of vegetation on grassland contour listed in 1934 was 75.75 per cent as compared to 33.30 per cent on closely adjoining unlisted areas.

The experimental areas have been grazed at the rate of one animal unit per five acres with no evidence of overstocking. Local range land under the AAA Program has an average assigned carrying capacity of one animal unit to 16 to 18 acres.

Solid contour listing of native grassland has been the most profitable and practical method of rejuvenating native grass pastures and increasing the carrying capacity; however, contour furrows with alternate strips left unlisted appear to be effective on relatively level areas. Recent studies at this station indicate that under certain conditions concentration of run-off on strip-listed areas may result in a higher carrying capacity than from an equal distribution of rainfall on solid listed grassland.

Grass Nursery Studies: Buffalo grass selection studies of 44 staminate and 44 pistillate plants were begun in 1934. A study of these selections has revealed a large amount of variation in the vegetative characteristics, yield of dry grass, seed production and seasonal growth. The highest yield of air-dry buffalo grass, 6,528 pounds per acre, was produced by a staminate plant, selection 4-6, while selection 3-9, a pistillate plant, produced 6,046 pounds. Nineteen of the more promising selections were sodded in increase blocks in 1938 for further study.

Selections were made from fifteen important native range grasses occurring in the region and were transplanted to the grass nursery for observation. The species which show promise of improvement from further selection are buffalo grass, blue grama, side-oats grama, little bluestem and switch grass.

Sixteen grass species, introductions from South Africa, Australia and Russia, were seeded in 1938. *Eragrostis curvula*, *Eragrostis lehmanniana*, and *Panicum antidotale* possess many desirable characteristics and warrant further study.

Clipping studies to give information on the effect of constant and deferred grazing on yield of pasture grass were begun in 1938 on 18 plats of buffalo grass and 18 plats of blue grama which were seeded the previous year. Excellent stands of both species were obtained. First year data show that the highest yield of forage was produced on plats clipped twice each year, at mid-summer and at the end of the year. The lowest yields were produced on plats which were clipped at intervals of two weeks throughout the season. Plats harvested at intervals of four weeks produced smaller yields for the year than those every eight weeks or plats clipped twice during the year. The yields obtained from plats

harvested once at the end of the season were somewhat lower than from plats harvested twice.

Seedings of buffalo grass and blue grama at intervals of two weeks, March to November, show that higher germination with a greater percentage survival of seedlings resulted from seedings made during the spring than in the summer or fall. The late summer and fall months were abnormally hot and dry.

Blue grama grass seeded in drills and covered one-half inch deep produced thicker stands with a higher percentage survival of seedlings than that broadcasted but not covered or that seeded in drills and covered one and two inches deep.

R. E. Dickson, B. C. Langley, and C. E. Fisher.

Cattle Feeding Experiments

Two projects inaugurated in 1935 and conducted since that time were continued during the past year.

Fattening Yearling Steers on Silage, Cottonseed Meal, Cottonseed Oil and Cotton Seed

Silage for Fattening: Results show that yearling steers can be well fattened in about 200 days on rations of silage and cottonseed meal without the use of grain. The method of feeding silage with cottonseed meal, or with cottonseed meal plus cotton seed, affords a means of disposing of large amounts of silage per head and has definite possibilities for profit when grains are scarce and high in price and silage is abundant and cheap. It has the disadvantage of producing only moderate gains because it is impossible for cattle to consume sufficient silage to secure the nutrients required for making high gains.

Sumac Silage vs. Kafir Silage: The chief difference between these two silages appeared to be in the yields of green forage, the sumac yielding eight tons per acre as compared to five tons of kafir. On this basis about 1.7 steers were fed per acre of sumac and 1.2 steers per acre of kafir. Two lots of steers fed the respective silages made the same gain on the basis of feedlot weights, although the lot fed sumac had an advantage of 16 pounds per head at market.

Comparison of Levels of Protein in the Ration: Three lots of cattle were fed 4.0, 5.5 and 7.0 pounds of cottonseed meal per head daily. The lot fed 4.0 pounds made slightly smaller gains and did not attain the finish of the other two lots. The most economical gains were made in the lot fed 5.5 pounds of meal. In the light of three years' work it is apparent that five to six pounds of meal is the practical amount to feed with silage for fattening yearling cattle.

Feeding Cottonseed Oil: Three lots of steers received 4.0 pounds of cottonseed meal with sumac silage to which was added .18, .58, and .98 pound of cottonseed oil. The results show that cottonseed oil has a feeding value. This value should be recognized in cottonseed meal and cottonseed cake having high oil content as well as in the whole, raw cotton seed. It is doubtful, however, if the price of cottonseed oil will ever drop to a level at which it will become an economical feed for beef cattle. Three years' results show that cottonseed oil, in amounts up to one pound per head daily, is not laxative for yearling cattle.

Feeding Cotton Seed: In experiments covering three years it has been found that 5.5 pounds of cottonseed meal is the practical amount to feed with sumac silage for yearling steers. Six and four-tenths pounds of cotton seed with one pound of cottonseed meal produced the same gain as the 5.5 pounds of cottonseed meal with .09 pound of cottonseed oil, both lots consuming a full feed of silage. The lot fed cotton seed consumed 7.71 pounds less silage per head daily than the lot fed meal.

Vitamin A Requirements for Beef Cattle and Sheep

(In cooperation with Divisions of Range Animal Husbandry, Chemistry, and Veterinary Science, and the Bureau of Animal Industry, U. S. D. A.)

In this experiment conducted at Substation No. 7, Spur, the fourth group of steers, 50 head of 487-pound weaned steer calves were started on a Vitamin A deficient ration consisting of three per cent of 60 per cent protein digester tankage, 10 per cent cottonseed meal, and 87 per cent cottonseed hulls and 0.10 pound of limestone flour per head daily on the 17th of November, 1937. They were fed as a group but upon depletion of vitamin A storage as indicated by a measurable degree of night blindness, each individual was placed in an individual pen and fed ground alfalfa hay to supply 800 micrograms of carotene per cwt. live weight daily until 35 head were depleted. At that time the remaining 15 were placed in individual pens and all 50 were divided as equally as possible into five groups of 10 each. All were started on a fattening ration consisting of three per cent of 60 per cent protein digester tankage, 15 per cent cottonseed meal, 30 per cent of finely ground threshed hegari grain, and 52 per cent cottonseed hulls and 0.10 pound limestone flour, and the seven depleted steers in each group were fed ground alfalfa hay to supply respective levels of 800-1,000-1,250-1,500-2,000 micrograms of carotene per cwt. live weight daily but the three undepleted steers in each group were not fed the alfalfa until they became depleted. The fattening ration was fed for a period of 140 days and sufficient grain was fed to change the average levels of carotene supplied during the period to 935-1,144-1,411-1,662 and 2,197 micrograms for the respective groups.

During the course of the experiment, the Division of Veterinary Science occasionally examined the structures of the eyes for any lesions and made

observations for any other clinical symptoms that might have developed, and also checked the night blindness of the steers with the attendant in charge. One steer in the group fed 800 micrograms of carotene and two steers in the group fed 1,000 micrograms of carotene developed corneal opacity. Hock swellings were observed in the groups which were fed up to 1,250 micrograms of carotene. The average time required for depletion of 138 days was in close agreement with the 136 days required in the 1936-37 test; however, appreciable variation was evident in the time required by individuals, the range being from 96 to 194 days. The steers also remained night blind on considerably higher levels of carotene than in previous years.

The groups which received 935 and 1,144 micrograms of carotene made significantly lower gain than the three higher levels. Each group of steers fattened and night blindness occurred on all levels but a lesser degree of night blindness and a higher degree of general well-being was apparent for the groups which received 1,662 and 2,197 micrograms of carotene. Additional work will be required to determine with certainty that 1,662 micrograms of carotene are required, as well as sufficient, for the best gains in weight, since some of the differences shown were within the limits of error. The procedure used in the selection of groups for the compared levels of carotene feeding will be continued in the ensuing test.

Four of the five steers from the 1936-37 experiment at Spur, which were removed to College Station and were receiving 450 micrograms of carotene, have died while being continued on this level. These steers survived 145, 153, 472, and 476 days. The fifth steer is still living and has been on 450 micrograms for 650 days. At the present time he appears to be in perfect health and weighs 1,200 pounds.

A paper entitled "Carotene Requirements for Fattening Beef Cattle" was read before the American Society of Animal Production in November, 1938, and appeared on pages 94-102 of the Proceedings. This paper reviews more fully the results thus far obtained in this study.

J. H. Jones, R. E. Dickson, J. M. Jones, J. K. Riggs, H. Schmidt.

SUBSTATION NO. 8, LUBBOCK

Substation No. 8 is located three miles east of Lubbock, Lubbock County; latitude 33 degrees and 37 minutes north, longitude 101 degrees and 45 minutes west; elevation 3,215 feet above sea level. The average annual rainfall over a period of 28 years was 18.96 inches, with yearly extremes of 8.73 and 31.88 inches. The rainfall for 1938 amounted to 16.52 inches. The station comprises 160 acres of land, 152 in cultivation and the remainder in pasture. The soil is of the Amarillo and Richfield fine sandy loam type, which is typical of a great portion of the region.

The station is the only one located on the High Plains region of Texas in a new agricultural section of the State.

Grain Sorghum Experiments

Grain Sorghum Varieties: The principal varieties of grain sorghums grown in this region are milo, kafir, and Hegari. Bulletin No. 459, "Grain Sorghum Varieties in Texas," covers the work with sorghums at this station for the period of 1912-1931. Beginning in 1932, a large number of new varieties, largely of hybrid parentage, have been grown in comparison with milo, kafir, and Hegari. The new varieties are made up of sorghums created to fill certain needs for harvesting, extreme earliness, and bundle-feeding. The average yield of 24 varieties in 1938 was 30.9 bushels per acre. The five highest and their yields were: Texas milo, Feterita x Premo, Wonder kafir, Texas Blackhul kafir, and 670 Dwarf Yellow milo with yields of 39.7, 37.6, 37.4, 35.0, and 34.3 bushels per acre.

Milo Row Spacing: This test is a comparison of what is locally known as "planting two and skipping two rows." This allows for cropping only two out of each four rows instead of every row as is the normal practice. Plant spacing remained constant at 18 inches where every row was cropped and where every two out of four were cropped. The average yield of threshed grain was 31.4 bushels to the acre on the two-row method, as compared to 42 bushels where every row was planted.

Grain Sorghum Breeding: The work with strains of Dwarf Yellow milo resistant to milo blight, *Pythium arrhenomanes*, has progressed to the point where a strain test consisting of thirty-two strains was planted for the purpose of comparing yields and other characteristics under plat conditions. Several superior strains were selected for future testing.

A distribution of some 14,000 pounds of this resistant seed was made this past spring through the Extension Service, vocational agricultural teachers, and directly to farmers. This seed went into 42 counties.

The breeding work in connection with producing a better silage type and better combine types showed considerable progress this season. A Red kafir-Hegari cross for silage purposes and two kafir-milo hybrids, in particular, showed to advantage.

A kafir hybrid strain with waxy endosperm was increased this year, and a feeding test will be conducted.

Several F_2 early segregates of a Dwarf Yellow and Early Yellow milo cross which appeared resistant to milo root rot were selected and will be further tested in the greenhouse to secure a resistant Early Yellow milo. Likewise, F_2 selections of (kafir-milo) x milo were made for a resistant Quadroon type.

Cotton Experiments

Cotton Varieties: Thirty-six varieties of cotton were grown in 1938, ranging in staple length from $\frac{3}{4}$ -inch for Half & Half to 1-3/32 for California Acala. Excessive rains and cool weather the first of the season necessitated replanting several times, and caused a great deal of angular

leaf spot in the seedling stage. Leaf worms caused minor damage during late August and early September. Clear, dry weather prevailed during the fall, producing ideal harvesting conditions. The average yield of lint cotton for all varieties was 204 pounds. The five highest yielding strains and the pounds of lint produced were: D. & P. L. 11A, 382; Stoneville 2B, 349; Mebane, 141, 302; Half & Half, 294; and Burnett, 283. The two lowest were: Olander Mebane, 121; and Texas Special, 130 pounds of lint to the acre.

Treatment of Cotton Seed: In a comparison of fuzzy and delinted seed, both planted May 24 at the rate of 20 pounds were acre, the fuzzy seed germinated at a faster rate and also had a higher germination. Delinted seed treated with Ceresan proved superior to non-treated, while untreated fuzzy was better than Ceresan-treated fuzzy seed. The use of a press wheel at planting time increased both the rapidity of germination and total amount.

In a similar planting made June 22, fuzzy seed showed both a greater total germination and faster rate. Delinted seed treated with Ceresan was superior to non-treated but where fuzzy seed was used the opposite was true. The use of a press wheel with fuzzy seed produced a more rapid rate of germination as well as a greater number of seedling plants.

Cotton Breeding: The cotton improvement program at this station has three objectives: First, to produce a very early maturing strain which can be used in years when late planting is necessary due to various causes; second, an unusually storm-proof cotton for use in mechanical harvesting; and third, to test strains to be grown for seed crushing purposes only.

The early-maturing strain had 29 when Acala had 6 and Paymaster 11 per cent of the total crop open. Yields were 228, 226, and 210 pounds of lint per acre, respectively.

In the storm-proof selection there was no cotton on the ground sixty days after the bolls were open. Crosses have been made to secure a more desirable length of fiber.

Crosses have been made with a lintless strain of Cleveland, which was found on the station in 1936. It is hoped to secure strains that will have sufficient fiber to prevent wasting of the seed and to determine whether the crop can be grown and harvested for crushing purposes only.

Cotton Plant Spacing and Fiber Length: This test is to determine the effect of different plant spacings upon yield, maturity, and fiber length. Acre yields of lint for three-, six-, nine-, twelve-, and eighteen-inch plant spacings were 222, 213, 202, 209, and 169 pounds, respectively. One hundred thirty-five days after planting eighteen-inch spacing had thirty per cent of the total crop open, while the balance of the spacings had from 36 to 38 per cent. Staple length this year indicated that there-and six-inch spacing would produce fiber 1/32-inch shorter than the balance of the spacings used.

Pasture Grass: On May 14, 1937, Buffalo grass (*Buchloe dactyloides*) was set out in a cultivated pasture area as reported in the 1937 report. Cages were placed over a small area in both the irrigated and non-irrigated sections this spring. Clippings were made at regular intervals to obtain information as to the probable yielding ability under these two conditions. The irrigated area which received, in addition to the normal rainfall, four irrigations, each of approximately three acre-inches, produced 2.38 tons of air-dry forage as compared to 1.84 from the non-irrigated.

Horticultural Experiments: Cold weather, accompanied by a hard driving wind April 6, 7, and 8 with temperatures as low as 24 degrees, killed practically all the fruit, as it was considerably advanced at that time.

Date and Method of Preparing Seed Bed: The seed bed is prepared during January and April. Two methods and depths were used, namely: plowing and listing and 3.5 and 7 inches deep.

Results with Grain Sorghums: January prepared ground averaged 39.9 bushels per acre as compared to 38.2 for April. Plowing averaged 39.2 bushels per acre, while listing averaged 38.4. Seven-inch prepared seed bed averaged 39.8 bushels per acre as compared to 37.9 bushels per acre for 3.5 inches. Date, method, or depth exerted little influence on production this season.

Results with Cotton: January prepared ground averaged 319 pounds of lint per acre as compared to 336 for April. Plowing averaged 325 pounds, listing 332. Seven-inch prepared seed bed averaged 340; three and one-half, 318.

Soil Fertility and Moisture Conservation: Sixty-four 1/10-acre plats are devoted to a study to determine the effect of continuous cropping, fallow, fertilizing with barnyard manure, green manure, and various crop rotations on both crop production and soil moisture. Cotton and grain sorghums are the crops grown, with sorgo used for green manure.

Results with Cotton: This year the average for the 21 plats was 394 pounds of lint per acre. The highest yield, 511 pounds, was obtained from a four-year rotation of cotton continuous, barnyard manure alternated with fallow, after grain sorghums after fallow after green manure; the lowest 326, was made from a three-year rotation, cotton after grain sorghum after fallow. Cotton continuously cropped for 23 years averaged 271 pounds. Where cotton had been continuously cropped for 24 years and barnyard fertilizer applied at the rate of 2,000 pounds per acre, the yield was 292 pounds.

Results with Grain Sorghums: Twenty-one plats were cropped to grain sorghums. The three highest plats were as follows:

Grain sorghum after fallow after green manure after cotton	41.2 bu.
Grain sorghum after cotton after fallow	40.9 bu.
Grain sorghum after cotton after fallow	40.6 bu.

Where grain sorghums have been grown continuously for 23 years, the average was 21.5 bushels, as compared to 24.8 bushels where barnyard fertilizer at the rate of 2,000 pounds per acre was applied.

Commercial Fertilizer: An application of 100 pounds of ammonia sulphate is applied to both cotton and grain sorghums. This year the unfertilized plats averaged 400 pounds of lint per acre and the fertilized 396. Where grain sorghums were cropped, unfertilized plats averaged 20 bushels as compared to 22.6 where fertilizer was used.

Barnyard Fertilizer and Cotton Burs: Plats receiving no fertilizer are compared with those receiving 2, 4, and 8 tons of barnyard fertilizer and two tons of cotton burs per acre. Excellent moisture existed throughout the winter, spring, and until middle August. Acre yields of lint cotton of 267, 303, 316, 278, and 283 pounds were obtained from no fertilizer, 2, 4, and 8 tons of barnyard fertilizer and 2 tons of cotton burs in the order named.

Cotton and Grain Sorghum Under Pump Irrigation: An experiment to determine the total amount of irrigation water necessary to produce maximum yields, and its date of application, was started in 1936. As set up, the experiment calls for the following treatments: No irrigation, a preplanting irrigation some time in February and another in April, one preplanting and one in early summer, one preplanting and two in summer some three to four weeks apart. All irrigations are to be applied at the rate of three acre-inches. The postplanting irrigations are to be applied, as nearly as possible, at the most effective time.

Results with Cotton: Plats receiving no water outside of rainfall averaged 360 pounds of lint per acre as compared to 401 for the one preplanting watering, 452 where two preplanting irrigations were made, 449 with one each of preplanting and postplanting, 487 with one preplanting and two postplanting.

Results with Grain Sorghums: Hegari was the grain sorghum used, and receiving the same treatment as above, the yields in order were 23.8, 28.9, 32.5, 58.0, and 65.6 bushels per acre.

Cotton Varieties Under Irrigation: Five varieties ranging in staple length from Half and Half with 13/16-inch to Rogers Acala with 1-1/32 inches were included in this test. In addition to the natural rainfall, three irrigations of three acre-inches each were made; one a preplanting on May 12, and the other two on August 6 and 20. Their yields and staple length were as follows: Half and Half, 937 with 13/16-inch; Rogers Acala, 799 with 1-1/32 inches; Jennings, 643 with 31/32-inch; Ferguson 406, 638 with 31/32; and Burnett 625 with 29/32.

Forest Nursery: In addition to maintaining a small arboretum, emphasis is laid on material suitable for windbreaks, shelterbelts, and woodlot plantings. In the past the following pines: Western Yellow (*P. ponderosa*), Austrian (*P. nigra*), Pinon (*P. edulis*), and Scotch (*P. sylvestris*), in the

order named, have been preferred. The last few years the Loblolly (*P. taeda*) has shown considerable promise because of the almost phenomenal growth.

D. L. Jones and Frank Gaines.

SUBSTATION NO. 9, BALMORHEA

Substation No. 9 is approximately four miles east of Balmorhea and is adjacent to the O. S. T. Highway. This area is served by the Pecos Valley Southern Railroad, a branch of the Texas & Pacific Railway. The station has an elevation of approximately 3,200 feet. The latitude is 31 degrees north, and the longitude 103 degrees west. The annual precipitation is very variable but is never sufficient to produce staple crops without irrigation. The average annual precipitation for the past sixteen years has been 13.93 inches. The evaporation is very high during the months from March to September, inclusive. This high rate of evaporation, together with the low precipitation, make the use of large amounts of irrigation water necessary in crop production. Water for irrigation comes principally from flowing springs but this is supplemented by flood water from the Davis Mountains which is caught and stored in a reservoir.

Work on the station has dealt principally with problems connected with the development of a better balanced agriculture in the irrigated sections of western Texas. This has included experimental work in the growing of a great many varieties of various kinds of horticultural and agronomic crops, and the development of a system of cattle feeding whereby cattle could be profitably fattened and finished with a maximum amount of locally grown roughages and a minimum amount of concentrates.

Fattening Steers in the Madera Valley

This experiment continues the study of methods of using large amounts of roughage feeds and limited amounts of concentrate feeds in fattening yearling steers. The six lots of ten 652-pound feeder steers received in respective order 0, 2, 3, 3, 4, and 5 pounds of ground alfalfa hay; 15.5, 13.4, 12.7, 11.7, 11.6 and 9.5 pounds of ground hegari fodder and 2.45 pounds ground threshed milo, 1.96 pounds cottonseed meal and 3.83 pounds of cottonseed per head daily for 194 days. The ground threshed milo was not added to the ration for the first 112 days. Lot 3 was self-fed the same ration as Lot 4, which was hand-fed twice daily.

The method of feeding involving the deferred feeding of grain and the use of large amounts of roughage feeds again produced economical gains and highly finished steers.

The differences in gain and finish between the various lots were small but were consistent with the results of the preceding trial in which the lots which received 2, 3, and 4 pounds of alfalfa made slightly greater gains than Lot 1 not fed alfalfa and Lot 6 fed 5 pounds of alfalfa.

The self-fed lot again had slight advantage over the hand-fed lot in gain and finish.

J. H. Jones, J. J. Bayles, J. M. Jones.

Agronomic Work

Since the climatic and soil conditions here limit the number of crops which may be successfully grown, the agronomic work of the station has been confined largely to the adapted staple crops, cotton, alfalfa, sorghums, and miscellaneous legumes.

The better strains of Acala cotton have proven to be the best adapted and the most suitable for planting under irrigation. This variety has been selected for planting this area as a "one variety" community.

Applications of fertilizers have shown that nitrogenous fertilizers will increase yields of cotton on land not recently planted to alfalfa, and that alfalfa will respond to applications of phosphorus. No increase in the yield of crops has been secured from the use of sulphur, potash, or lime.

D. Y. Milo has been the best strictly grain sorghum in variety tests, but hegari is superior as a fodder crop where the entire plant is ground and fed to cattle. Sumac is one of the best varieties of forage sorghums. Since damage by birds is very severe on grain sorghums after they are in the shock, it has been found that a large amount of protection may be obtained for hegari by mixing about 10 per cent of the taller growing Sumac with the hegari seed at the time of planting.

Although a large number of legumes have been tried none have been found which could successfully compete with alfalfa and sweet clover under these conditions.

Fruit Adaptability Trials

Although the climatic and soil conditions here are not favorable for the production of commercial orchards, every farmstead should have a few trees of those fruits best adapted, and work on the station has indicated that these plantings should include western varieties of pecans, peaches, plums, pears, and apricots.

Vineyard Management

A large number of varieties of grapes have been tried out in the vineyard over a period of fourteen years. Very few American varieties have been able to withstand the climatic conditions prevailing here. All varieties have suffered from root rot except Champanel, Mustang, and Black Spanish, which seem to have a high degree of resistance to the disease and might be used as rootstocks for other more desirable varieties. The Thompson Seedless and Rose of Peru have been two of the most promising vinifera varieties.

Ornamental Adaptability Trials

During the past ten years a large number of varieties of ornamentals have been planted on the substation to determine their adaptability to this section where growing conditions are unfavorable for many ornamentals commonly used in other sections. Coniferous evergreens which have proven themselves hardy to these conditions include the following: Pfitzer's juniper, Arizona cypress, Red cedar, Italian cypress, most of the varieties of arborvitae, and Ramsey's hybrid. Other varieties which have done well are live oak, honey suckle, flowering willow, flowering pomegranate, Arizona ash, euonymus, *Ulmus parvifolia*, black locust, and hardy roses.

The Chinese elm, Russian olive, and cottonwood make a rapid growth on soils not infected with cotton root rot, to which they are very susceptible.

J. J. Bayles.

SUBSTATION NO. 10, FEEDING AND BREEDING STATION

Substation No. 10 is located at College Station, Brazos county, one mile northwest of the College on the public highway; its latitude is 30 degrees north and its longitude 96 degrees west; it is 308 feet above sea-level. The annual average rainfall over a period of 40 years was 38.02 inches. The land owned and assigned to the Feeding and Breeding Station comprises 920.8 acres.

The work of this station embraces investigations in the feeding, breeding, and management of swine, dairy cattle, poultry, goats, and sheep. Progress of work on projects with these animals is treated elsewhere in this report under the respective divisions concerned.

Of the land embraced in this station, approximately 150 acres are in cultivated crops, 200 acres in improved pasture, and the remaining 570.8 acres in native pasture.

SUBSTATION NO. 11, NACOGDOCHES

Substation No. 11 is located one-half mile north of the city limits of Nacogdoches, Nacogdoches County, on State Highway No. 35; its latitude is 32 degrees north and its longitude 94 degrees west; its elevation is 292 feet above sea level. The average annual rainfall over a period of 26 years was 48.66 inches, with a total rainfall of 39.92 inches for the 1938 season. During this period an average of 15.52 inches, or 31 per cent of the total average annual rainfall occurred during the months of May, June, July, and August, but this year 12.27 inches has fallen during these months. The average length of growing season during a 25-year period is 248 days, with the average last killing frost in the spring occurring March 13, and the average first killing frost in the fall occur-

ring November 15. The purpose of this station is to serve the region of Texas in which the Nacogdoches soils, or "Redlands" occur. The redlands of the Nacogdoches soil series were among the earliest-settled farm lands in the State. The soil in the virgin state is productive, but since much of it has been in cultivation for a long time, one of the chief problems of the station is that of finding the most effective and the practicable systems of cropping for building up and maintaining soil fertility; other studies concern the use of fertilizers, including rate and time of application, and the development of horticultural and agronomic crops suited to a diversified agricultural program for this region.

Soil Improvement Investigations

Preliminary Studies of Artificial Plats for Field Experiments

In continuing the studies on the use of concrete tank plats for soil fertility tests Sudan grass was grown again during the 1938 season in 1/1000 acre plats. Nine fertilizer treatments and one soil check were replicated six times in the available sixty plats. Only one cutting of forage was secured on account of prevailing dry weather following the first cutting.

A summary of the yields of dry forage produced by the various treatments shows an increase from their use in every instance over that of the unfertilized areas. The use of the formula 4-8-4 at the rate of 400 pounds per acre produced greater yields than the rates of 200, and 600 pounds. Comparable amounts of 4-8-4 and 4-8-0 fertilizers showed an increase in yield of the 4-8-4 over the 4-8-0 formulas. There was a significant increase in the yield of Sudan from the use of six and eight per cent of phosphoric acid. The absence of nitrogen from the formula showed this plant food to be more of a limiting factor than either phosphoric acid or potash in the production of Sudan grass hay.

A four-year summary shows a definite and consistent increase in forage production where the amount of a 4-8-4 fertilizer was increased from 200 to 400 to 600 pounds per acre. Potash showed no increase from its use. Consistent increases were obtained from the use of phosphoric acid from none to six to eight per cent. Nitrogen is apparently the main plant food required as varying amounts from none to six per cent produced consistent and significant increases of dry forage.

Fertilizer and Seed Treatment Studies

The cooperative project initiated during the 1936 season on the effect of disturbing the seed bed where applying fertilizer at different positions in relation to the cotton seed, and the use of fungicides on cotton seed prior to planting was continued during the year. The results of the study are reported fully in the Division of Agricultural Engineering.

Green Manure Studies

During the fall of 1937 a project was initiated for the study of the comparative value of oats and Hairy vetch when used for green manure purposes preceding cotton. A review of the yields of lint cotton obtained during the 1938 season shows the greatest production to have been derived from the areas planted to Hairy vetch alone. A mixture of oats and Hairy vetch plus 400 pounds per acre of 0-8-4 fertilizer applied at the time of planting the green manure crop produced the second highest yields. The next high yield of lint was produced by the planting of Hairy vetch plus the fertilizer treatment of 400 pounds per acre of a 4-8-4 fertilizer with the phosphate and potash applied to the vetch and the nitrogen to the cotton.

Hairy vetch planted alone produced greater yields of green forage than oats alone or a combination planting of the two.

Agronomic Crop Investigations

Cotton Varieties

Twelve varieties were grown in the cotton-variety test in 1938 with six replications of each variety. New Boykin made the highest yield with 306 pounds of lint per acre, followed in order by Bryant Mebane with 303 pounds of lint, Bagley with 294 pounds of lint, Lone Star with 291 pounds of lint, and D. & P. L. 11A with 275 pounds lint per acre. All varieties had a staple of one inch or better with the exception of New Boykin, with 15/16-inch and Half & Half with 13/16-inch.

The results of the variety tests to date show that Rogers Acala, New Boykin, Ferguson 406, Half and Half, and Lankart have been the most profitable varieties, taking into consideration yield, length of lint, percentage of lint, and money value per acre.

Cotton Breeding

In a continuation of the cotton breeding work of this station, 63 progeny rows of plant selections from the 1937 F₁ progeny rows, and their parents, were grown. These selections were from strains of a cross of Half & Half X Lone Star made by D. T. Killough, Cotton Breeder, Division of Agronomy. Within these 63 progeny rows, three plants of desirable types were selected per row for inbreeding purposes, eight to twelve selfed bolls per plant being secured. Ten individual plants from each progeny row were harvested separately for further laboratory selection of these inbred plants for planting during the 1939 season. A planting for increase during 1939 was made during the season of 69 progeny rows from individual open pollinated selected plants from best progeny rows grown during 1937. Ten individual plants from each progeny row were selected and harvested for further laboratory analysis as to length, per-

centage, and yield of staple. One-lock samples were taken from each individual plant in all of the progeny rows for laboratory analysis in order to have a comparative standard for making the field selections.

During the year work was continued on the backcrossing of the selfed parents Half & Half and Lone Star to 20 backcrossed strains in the B/C₃ generation.

A randomized field test begun during 1935 was continued this season with 36 selected selfed strains of the Half & Half x Lone Star Cross, selfed selections of the parent varieties, along with commercial seed of the two parent varieties. Results this season show that 12 of the 36 increase strains in the eighth hybrid generation grown in six replications produced higher yields of lint than the most productive parent, Half and Half. Two of the strains had a percentage of lint greater than the high percentage parent, Half and Half. Five strains had a length of staple equal to the longer lint parent, Lone Star; and two showed an increase of 1/32-inch over the Lone Star parent.

For the four-year period 1935-38, several of the Half and Half x Lone Star strains showed increases in yield over the high-yielding Half and Half parent, ranging up to 26 per cent. The fiber in the hybrids is not as coarse as the fiber in Half and Half, and tends to approach the finer-fibered Lone Star parent. Further selections are being made to obtain high-yielding types equal in fiber properties to that of Lone Star.

During the season a large number of individual selected plants of the D. & P. L. 11A were selfed in order to secure known parentage for further use in crossing on a number of strains of the Half & Half x Lone Star Cross.

The cotton strains of the late Jim Greer of Appleby, Texas, were released to the station and grown during the 1938 season. A number of individual plants from each strain were selected and selfed for further observation in the hereding block.

Regional Cotton Wilt Variety Studies

In cooperation with the Division of Cotton and Other Fiber Crops and Diseases, Bureau Plant Industry, U. S. Dept. of Agriculture, a test was conducted at Jacksonville to determine the relative resistance of different varieties of cotton to cotton wilt fungus, *F. vasinfectum*, and the effect of the application of different kinds of potash fertilizers on the incidence of the disease.

The following varieties of cotton were found to combine adequately strong resistance to *Fusarium vasinfectum* with large yields of long-staple cotton: Clewewilt 6, Cook 144-68, Dixie Triumph 12, Dixie 14-5-2, Dixie Triumph 55-85, Miller 610, and Rowden 2088. Delta and Pineland cotton is more wilt resistant than Half and Half or Coker 100, and is becoming popular in East Texas.

The cotton without potash fertilizer showed prominent symptoms of potash starvation including interveinal yellowing and browning, and severe defoliation with the first drought in July.

P. A. Young.

Corn Inheritance and Improvement Test

The work at this station pertaining to the improvement of corn for this section continues the work in the development of a yellow prolific variety. In this connection 50 selfed ears were selected from the 1937 lot and grown in four replications during 1938. These were cross-pollinated by open pollinated ears of the Texas Golden Prolific. From the planting 14 strains were selected for increase and for a yield strain test during the 1939 season.

In an effort to advance the maturity and to reduce height of stalk of the Texas Golden Prolific variety it was crossed with Yellow Surcropper during 1937. A number of the hybrids were grown in the greenhouse at College Station and backcrossed to the Texas Golden Prolific during the winter of 1937-38. Further backcrosses were made in the field during the 1938 season.

Horticultural Crop Investigations

Blackberry and Dewberry Variety Studies

Information obtained on blackberry and dewberry varieties fruiting at the station for their first time during the 1938 season did not reveal an outstanding variety. The nectarberry has been a disappointment as compared with the Young dewberry and the Boysenberry.

Blackberry and Dewberry Breeding

Rubus breeding at this station is being conducted along two lines to introduce high-yielding varieties and strains that are superior in flavor and quality to the existing adapted varieties. At the same time an effort is being made to establish certain desirable vegetative characteristics.

First, a large number of selected varieties have been inbred in order to isolate the factors desired for further crossing. Second, a large number of crosses have been made, with the Young dewberry, Crandall's Early, and Hall's Lawton blackberries as pollen parents. These varieties were crossed with a number of other varieties having desired characters and also crossed with each other.

In continuation of the breeding program several hundred self-pollinations were made on a number of varieties and also on a large number of F_1 selfs and hybrids. Only a limited number of inter-varietal crosses were made during the season.

Approximately four thousand berry seedlings were moved to the trial grounds during the 1938 season. These seedlings represent F_1 's, F_2 's and backcrosses. Of several hundred F_1 selfs and hybrids examined during the 1938 season no individual seedling approached the standard of its parent or parents when the desired factors of production, quality, and freedom of disease were considered. However, in the case of many seedlings a sufficient number of promising characters were evident as to warrant the use of the material for further breeding studies.

Adaptability Investigations with Fruit Crops

During the year further material was assembled for the adaptability study of fruit varieties in East Texas. The station orchard consists of 180 varieties and selections of peaches, 13 varieties and selections of plums, and 6 varieties of pears.

Of the 19 peach varieties producing marketable fruit this season the varieties Uneeda, Frank, Henderson's Elberta Cling, and a selection known as Lot No. 15, were outstanding for their yield. On the merit of one season's test the Uneeda has a possibility of filling the need for an early maturing peach of high quality although it is a white cling and tender for long shipment.

In studying the cold requirements of the peach varieties for normal blooming thermograph records show a total of 168 hours of 32 degrees or less during the 1937-38 season, 955 hours below 45 degrees, 1,346 hours below 50 degrees, 1,707 hours below 55 degrees, and 2,080 hours below 60 degrees. A total of 18 varieties were studied during the season.

Ornamental Adaptation Study

The purpose of this project is to have at this station specimens of both local and foreign plants in order to accumulate ecological data for the local nurserymen and landscape gardeners. A large portion of the material is used in developing the landscape design of the station farmstead. Such material included in the test this year does not have sufficient promise as to merit its being described in detail.

Tung Oil Studies

In continuing the studies on the adaptation of the Tung tree to East Texas eight acres of Norfolk fine sandy loam were leased for planting seedlings grown in the station nursery. These seedlings are from trees recognized as late blooming or for their unusual heavy production in an effort to locate a late-blooming and heavy-producing selection.

Of the 15 seedlings growing under cultivated conditions here at the Station two were outstanding in their production; tree No. 7 producing 69 pounds of nuts in the husk and tree No. 8 48 pounds. Tree vigor is

apparently the cause of the production as date of blooming coincides with other trees in the plantation.

No results were secured from the cooperative fertilizer test on Tung trees with the Fullers Earth Plant, Nacogdoches, Texas, during the 1938 season. The lot of trees previously used as checks in that they did not receive any fertilizer were given treatment similar to the fertilizer area this season. This cooperative work is being discontinued.

Reforestation

Slash Pine Adaptation Studies

A cooperative adaptation test on Slash pine to the Nacogdoches soils is being conducted with the Texas Forest Service. Growth records obtained during the 1938 season showed an average growth during the first six months of 43.6 inches per tree, and a growth of 6.8 inches average for the 72 trees during the second six-month period. The average height of all trees at the end of the season was 15.6 feet with the tallest tree being 20.6 feet high. Diameter measurements of the eight-year-old trees shows an average of 3.02 inches.

Introduction of New Plants

A cooperative project with the Bureau of Plant Industry, U. S. D. A., for the study of the adaptation of Canaigre was started during the 1937-38 season. A planting of 50 tubers on Ruston fine sandy loam showed an emergence of 64 per cent. From the new plants 96 new tubers were harvested with a total weight of 6,702 grams. The results were not sufficiently promising as to warrant a second test of the material.

H. F. Morris.

Tomato Disease Studies

Studies were made at College Station, Jacksonville, and Nacogdoches during the year on a number of diseases affecting tomatoes in East Texas. The report of the work at College Station and of the Tomato Disease Laboratory at Jacksonville is included in the report of this station.

Chemical control of soil-borne pathogenic organisms

Root knot, *Heterodera marioni*. Chloropicrin and carbon bisulphide practically controlled the root-knot nematode, *Heterodera marioni*, when injected into the soil at the rate of 300 pounds per acre and 1,000 pounds per acre, respectively. Immediately after injection, the soil was covered with glue-coated paper. Wetting the top three inches of soil with water also provided a satisfactory cover for retarding the escape of the chemical.

Lye applied to the soil at the rate of 1,470 pounds per acre and formaldehyde applied at 1,000 pounds per acre failed to give effective practical control of root knot.

Fusarium wilt, *Fusarium lycopersici*. The application of chloropicrin to wilt-infested soil at the rate of 300 pounds per acre effectively controlled *Fusarium lycopersici*, the pathogen causing tomato wilt.

Damping-off organisms. Hot bed and cold frame soil was free of damping-off disease after it was treated with chloropicrin.

P. A. Young.

Southern blight, *Sclerotium rolfsii*, and others. In a continued effort to determine the value of 10 per cent sulphuric acid as a control on the soil organisms *Fusarium* sp., *Sclerotium rolfsii*, and nematodes pathogenic to tomatoes a planting was made during the 1938 season in both treated and untreated areas. Records obtained as to the date each plant died and the main cause of its death showed a large per cent of the dead plants in the treated area to have had one or both of the above diseases, and nematode infestation occurred on a number of plants.

H. F. Morris.

Control of damping-off in seed beds

Chloropicrin and formaldehyde were effective in disinfecting soil heavily infested with the pathogenic fungi causing the damping-off disease of seedlings. Soil applications of Cuprocide 54 and Semesan were beneficial in controlling post-emergence damping-off of tomato seedlings when applied to the soil immediately after planting, followed by two applications at weekly intervals.

Seed treatments with Cuprocide, Metrox, and DuBay 1155 FF practically controlled pre-emergence damping-off in soils heavily infested with the parasites causing this disease.

Abundant light is necessary to the production of healthy plants. Raising the hot bed and cold frame sheets on calm days whenever the daytime temperature is above 40° F. reduces the amount of damping-off damage.

Tests indicate that Preservitol and creosote are satisfactory preservatives and disinfectants for old lumber in hot beds and cold frames and that both can be used without injurious effects to the seedlings.

P. A. Young.

Field tests for resistance to tomato wilt (*F. lycopersici*)

The percentages of wilt-resistance of tomato varieties was accurately determined in two fields having a maximum infestation of *Fusarium lycopersici* in the practical absence of other parasitic diseases. A wilt resistance of 70 per cent or more is needed for commercially valuable

varieties of tomatoes in this area. Of 59 varieties including 144 selections tested, selections of Blair Forcing, Buckeye State, Illinois Baltimore, Louisiana Pink, Louisiana Red, Marglobe, Riverside, and Rutgers showed the strongest wilt resistance. In contrast, selections of the following varieties were at least 60 per cent less resistant to *Fusarium lycopersici*: Red Rock, Stone, and crosses with Earliana. Plants of twelve varieties of tomatoes survived more than 155 days after emergence as further evidence of their wilt resistance.

The yields of 14 tomato varieties were determined in relation to their wilt resistance. Pritchard, Michigan State, Break O'Day, Rutgers, Louisiana Pink, and Marglobe gave the best yields of marketable fruit in this test, in the order mentioned. The wilt-susceptible varieties, Stone and Early Detroit, yielded less than a ton of fruit per acre. In smaller tests, wilt resistant varieties Riverside, Illinois Baltimore, Long Calyx Forcing, and selections of Newport 5 gave desirable yields of marketable fruit.

Infestation of tomato roots with the root-knot nematode (*Heterodera marioni*) seriously decreased the resistance of many varieties of tomatoes to *Fusarium lycopersici*.

P. A. Young.

Longevity and transmission studies with tomato wilt. Continuing the work previously reported, cultures have been made with pieces of root and stem from tomato plants infected with wilt, *Fusarium lycopersici*, collected in 1933, 1935, and 1936 (stored air-dry). It was found that the wilt organism was still alive. More than 5,000 tomato seeds taken from fruits of wilt-infected plants were cultured to determine whether the organism was borne by the seed. As in 1937, *F. lycopersici* was not obtained in culture from the seed.

G. E. Altstatt.

Blossom-end rot, a physiological abnormality

Tests indicate that weekly, shallow cultivation between tomato rows throughout the growing and harvest seasons apparently decreases the severity of blossom-end rot and puff by aiding the plants in securing the most favorable and regular supply of water available each year. Such cultivation cuts the undependable, nearly superficial tomato roots between the rows, decreases the removal of fertilizer and water by weeds, and provides a surface mulch of dry soil that may delay the evaporation of capillary water from wet soil.

In conjunction with the experiments to determine the relative susceptibility of different varieties to *Fusarium* wilt, records were also taken on the numbers of fruits having blossom-end rot. Most of the tomato selections showed fair resistance to blossom-end rot. In contrast, one or more selections of each of the following varieties were seriously susceptible to blossom-end rot: Baltimore, Brown's Special, Buckeye State, Century, Globelle, Illinois Baltimore, Illinois Pride, Indiana Baltimore, Lou-

isiana Dixie, Louisiana Pink, Louisiana Red, Marglobe, Marvana, Prairieana, Riverside, and Rutgers.

P. A. Young.

Seed transmission of bacterial spot

Seed from fruits affected with bacterial spot, *Bacterium vesicatorium*, have been cultured, and several bacterial colonies have been isolated from them. These colonies are being tested on young plants to determine their pathogenicity. Some of this seed was planted in pasteurized soil to determine whether the disease would be transmitted through the seed to the plant. No evidence confirming this has been found to date.

G. E. Altstatt.

Southern blight

Studies on the life history of the Southern blight organism, *Sclerotium rolfsii*, are being made, and different varieties of tomatoes are being tested to determine whether some may be resistant to this organism.

G. E. Altstatt.

Effect of sprays on tomato plants and foliage diseases

It was reported previously (1937) that sprays applied during a relatively dry year, and when the plants were almost free of foliage diseases, actually decreased the yields of marketable tomatoes. In 1938, a year of abundant rainfall, but also relatively free of foliage diseases, the decrease in yield was much less. Four applications of Bordow, Bordeaux, and Cuprocid with cotton seed oil resulted in tomato yields a little lower than the yield of the unsprayed plants. In contrast, Basicop, Copper Hydro 40, Cuprocid 54, Cupro-K, and Z-O resulted in small increases in the yields.

P. A. Young.

White-flowered tomato

A white-flowered selection of tomato promises economic value. This T 161 was selected from one plant of X-ray treated Marglobe, and showed 78 per cent resistance to Fusarium wilt. The 66 plants segregated into 77 per cent of the plants having normal dark yellow flowers and 23 per cent of the plants having white to very light yellow flowers with some awl shaped petals. This is nearly a 3 to 1 ratio which indicates that the white-flower character is a Mendelian recessive. Seed from a white-flowered plant produced only white-flowered plants in the greenhouse. The white-flower character makes this a new horticultural variety of tomato.

P. A. Young.

Pepper-tomato

Tomato plants of P. I. 117566 from Brazil had red, vertically wrinkled fruits one to two inches long and nearly one inch wide. Nearly all of the fruits were completely puffed and hollow except for the seed mass, thus

resembling pepper fruits. The plants were typical tomatoes in other characters. This may be a new taxonomic variety of *Lycopersicon*, morphologically distinguished by nearly hollow fruits. It showed strong resistance to *Fusarium* wilt.

P. A. Young.

EAST TEXAS PASTURE INVESTIGATIONS, LUFKIN

The location of the East Texas Pasture Investigations is six miles west of Lufkin, Angelina County, latitude 31 degrees north and longitude 94 degrees west on the Lufkin-Huntsville Highway Number 94. The property is on the south side of the highway and adjacent to the Hudson Consolidated School. It comprises 228.67 acres of which 217.57 acres are owned and 11.1 acres are leased. The majority of the land is utilized for grazing and timber production, with only 18 acres being cultivated this year. About 150 acres are covered with young pine and hardwood timber. The once dense growth of underbrush has been cut out of most of this acreage. The average annual rainfall from 1934 to 1938 is 47.98 inches with extremes of 60.71 inches in 1935 and 38.51 in 1936. The total rainfall this year was 44.49 inches. Until weather recording instruments other than a rain gauge are installed, such information as temperature, atmospheric humidity, evaporation, and wind movement obtained at Substation No. 11, Nacogdoches, only 20 miles north, is considered applicable to this location. The average length of the growing season is between 250 and 260 days. The soil is considered predominantly Lufkin fine sand and sandy loam, which is characteristic of a great part of the land in the East Texas Forest Region. There are no rocks nor gravel on or near the surface in this soil. The top soil is greyish in color and very finely textured. The subsoil is approximately the same color and very impervious. This soil is slightly acid in reaction and low in organic matter. The elevation ranges from 217 to 270 feet from the southeast to the northwest corners of the property, respectively, and this gradual slope is broken only by several crooked gulleys and sand mounds. Water supplies of sufficient strength for small pumps are found at depths of 80 to 100 feet, but only in veins.

The shrubby plant coverage, consisting mainly of French or Spanish Mulberry, Youpon, and Wax Myrtle, furnishes browse of very little if any value. The native grass coverage consisting mainly of the sages and other coarse, rather tall, bunch-type grasses is of value for a relatively short period during the year. The nutritive value is considered rather low at all times. There are no sod-forming grasses unless bermuda and carpet grass are to be considered as native.

The principal problems with which this station deals are those of beef cattle and pasture improvement. Means for improving sugar cane grown for sirup are being studied. The station represents the entire East Texas Forest Region in these studies. According to the Texas Forest Service in its circular No. 8, there are approximately 1,414,000 acres of cut-over

pine and hardwood land in East Texas that now have no reproduction of timber. Very little utilization is being made of this land for any other purpose. If this land is not reproducing timber, then it should lend itself more readily to livestock production than most any other agricultural enterprise. However, at present, when the cut-over land is being utilized for stock-raising, low-quality stock are the rule with high-quality stock the exception.

Livestock and Pasture Improvement Investigations

High-grade Hereford cattle being grazed on the station's improved pastures continued to grow and develop during the year. Twenty-three head of four-year-old cows were averaging almost 1,200 pounds at their height of condition in October, however, most of the cows were dry. Sterility of the herd bull is considered to have caused an almost complete loss of a calf crop this year. These cows have been on the station since they were weaned calves. Four heifer yearlings, saved from the 1937 calf crop for replacement purposes were averaging 715 pounds in October also. One bull calf, dropped in April and sold at six months of age, weighed 455 pounds. The entire herd was carried on 42 acres of improved pasture land from March 1 to December 1 without supplemental feed. During this period approximately 600 bales of hay were cut from this same pasture.

No death losses occurred in the herd throughout the year with the exception of one calf that was born dead with hydrocephalus. There was no outbreak of contagious diseases and the herd was not bothered materially by parasites, either external or internal, as far as objective symptoms were concerned.

The forage plants furnishing most of the grazing in the improved pastures were White Dutch, Hop, and Persian clovers during the late winter and spring; Carpet, Dallis, Bermuda grass and lespedeza during the summer and fall. These pastures are located on typical East Texas, creek-bottom, old-field land with rather poor drainage and subject to overflow.

Although no supplemental feeds were supplied the cattle while on these pastures, all cattle not being used for other experimental purposes were furnished a mineral mixture consisting of two parts feeding bonemeal and one part salt as a lick. Well water was supplied through troughs located in each five-acre pasture. In order to furnish more variety and freshness in the forage for the cattle and also to protect the pastures from overgrazing and excess tramping, daily rotation was practiced as far as possible on the eight small pastures.

Mineral and Protein Deficiencies in the East Texas Forest Region

The satisfactory gain and growth of the beef cattle herd has rather definitely indicated that livestock grazed on improved fertilized pastures

in the region obtain most of the feed nutrients and minerals required for good development. Forage samples harvested from June to November from an improved fertilized bottom pasture had an average content of 11.5 per cent protein, 0.80 per cent calcium oxide, and 0.43 per cent phosphoric acid, while samples from an upland unfertilized pasture had a content of only 7.15 per cent protein, 0.44 per cent calcium oxide, and 0.26 per cent phosphoric acid.

In the test for the effect of a copper supplement, described in the 1937 annual report, there was no difference in gain with cows, and body measurements revealed no significant difference in growth of calves nor was the mean difference in gain of 24 pounds per head favoring the calves which received copper great enough to be significant.

The lack of a calf crop for 1938 and the sale of the 1937 calf crop in May limited experimental work with cattle; however, a study of feeding bone meal and di-calcium phosphate as sources of phosphorus in self-fed salt licks was initiated with 20 cows, 10 per group, on November 2, 1938.

J. H. Jones, E. K. Crouch, R. H. Hensel, E. B. Reynolds.

Angora Goats: Fifteen head of two-year-old Angora does and an Angora buck brought to the station from Sonora, Texas, have been under observation since June 1937. One of the does died during the winter. Only three kids were dropped in the spring of which one was born dead and the other two were raised. Both were bucks and they grew and developed fairly well. The does have not developed as rapidly as they should have. The mothers of the two buck kids died this fall. It seems that their strength was taxed so severely in raising the kids that they were never able to regain this lost strength. From these observations it appears that Angoras cannot be raised successfully in the East Texas Forest Region. However, it may be that grown goats shipped into this region and carried just for the mohair production, such as large wethers, would be successful. These goats are shearing normal amounts of good quality mohair.

Permanent Pasture Studies: The first year's growth of Persian clover in the improved pastures did not help to make the pastures earlier—the purpose for which it was planted. However, it did make a surprisingly good growth in the spring and reseeded well, and at present there are good indications that this clover will serve to bring on earlier grazing after it has had sufficient time to become well established. A second application of 34 per cent phosphate at the rate of 300 pounds per acre was not profitable as judged by the first year's forage production. From these results it appears that one good application of phosphate is sufficient for several years on pastures of this type. Well matured clover hay cut from the improved pastures and sold to farmers in this region for the purpose of getting the clovers started in their own pastures in an economical way is reported to be giving good results. The pastures were mowed twice during the growing season. The total yield for the pastures

this year was the furnishing of sufficient grazing for a breeding herd of 27 cows from March 1 to December 1 and 600 bales of hay.

Throughout the year forage samples were taken each month in both the improved and unimproved pastures to obtain comparative chemical analyses from which the value of the improved pastures can be more accurately determined.

In a continuation of a study of the effect of fertilizers on native pastures the following results were obtained from an average of four clip-pings: A treatment of 0-116-0 produced the greatest yield with a treatment of 35-58-24 running second; and a treatment of 35-0-0 fell short of the production on the untreated area. Since the treatments that were high in nitrogen gave the greatest increase in yield the first year after application and a treatment without the nitrogen but high in phosphate gave the greatest increase the second year after application, the indications are that phosphate treatments are the only ones that have a chance to be profitable because it is evident that from the relatively heavy applications of all the fertilizers used and the relatively small increases in yield per year over the untreated that the fertilizers must have a lasting effect to be profitable.

The effect of mineral fertilization on establishment and survival of clovers on native pasture resulted in all the clovers responding readily to applications of phosphate, however, none of the clovers showed satisfactory increases in yield beyond 400 pounds of phosphate per acre with the exception of Persian clover, which responded satisfactorily to the highest application of 1,000 pounds per acre. None of the clovers responded to applications of potash and lime. A similar test in which different rates of phosphate were applied to three strains of Subterranean clover resulted in marked increases in the yield for each of the strains as the phosphate treatment was increased. The rates of application were: none, 200, 400, 800, and 1,200 pounds of superphosphate.

In the woodland pasture and timber investigation work, the areas that have been thinned were found to be growing twice as fast or, in other words, making twice as many board feet per acre as those not thinned. This work was done by the Texas Forest Service and represented its first measurement of the trees in the test since the outset in 1934. Our part in this study is to observe the changes in the forage coverage caused by the thinning of the timber. As reported previously, the indications are that the per cent forage coverage will range from very low to nothing where pine timber is growing in stands thicker than 175 trees per acre.

Of the new grasses and legumes grown for the purpose of trying to find forage plants of higher grazing value than those native or adapted plants already in use, none were found with the necessary characteristics to be of more value, although approximately 110 different plants were

under observation during the year. One plant that had not shown any promise previously was found to be spreading by its seeds from the cultivated plat out into native grass sod. This plant is *Andropogon intermedius*, and although it is demonstrating its aggressiveness, we have yet to determine its palatability. *Paspalum malacophyllum* is managing to hold its own fairly well while growing in native pasture sod that is not being grazed. Saint Augustine grass is spreading slowly in the improved pasture sod after being transplanted from the protected area.

In our search for a satisfactory temporary winter pasture, a planting of Oats, Hairy vetch, White Dutch clover, and Yellow Melilotus was made on old-field upland last winter. The results were the same as those of previous work of this kind in that there was not an ample growth for even moderate grazing during the months of December, January, and February, when it is most needed.

Sugar Cane Studies

Sugar cane is grown in this region for sirup production entirely, and the variety most commonly used is Louisiana Purple. However, it has become so badly infected with mosaic disease that, coupled with the annual decrease in soil fertility, the yields of sirup per acre have decreased materially. This station is studying the ways of bringing the yields back to normal through the introduction of new varieties of sugar cane which have been developed and distributed by the United States Department of Agriculture for their resistance or tolerance of the mosaic disease.

Variety Test: Only one test was made this year and it included twelve varieties, namely: Co. 290, C.P. 807, P.O.J. 234, P.O.J. 213, Co. 281, P.O.J. 36M, C.P. 29-320, C.P. 28-11, C.P. 28-19, and three strains of Louisiana Purple. The growing season for sugar cane was somewhat above the average which caused the results to be a little different from those of the past year's study. All of the yields were high, but with the good growing conditions the mosaic disease did not retard the growth of the Louisiana Purple cane as much as usual; therefore one of these strains produced more sirup than some of the low producing improved varieties. The variety with the highest yield was C.P. 807, with 344 gallons of sirup per acre and the one with the lowest yield was the striped strain of Louisiana Purple, with only 150 gallons. The two varieties with the highest five-year average of sirup per acre are C.P. 807 with 246 gallons and Co. 290 with 228 gallons. The Louisiana Purple strain has a similar average of only 122 gallons. There is very little difference between the quality and flavor of the improved cane and that of the Louisiana Purple, which is generally considered to make a sirup of very fine quality.

E. K. Crouch.

SUBSTATION NO. 12, CHILLICOTHE

Substation No. 12 is located four and one-half miles south and one mile west of Chillicothe, Hardeman County, longitude 99 degrees west and latitude 34 degrees north and elevation 1,406 feet above sea level. The station serves a region in the northern part of the Rolling Plains area in which the Vernon, Foard, Abilene, and Miles soils predominate. The average annual rainfall at this point is almost 25 inches.

The Station was established in 1905 on leased land as a forage crop testing station operated by the United States Department of Agriculture and the Texas Agricultural Experiment Station. The cooperation has continued to the present. In 1916 the State of Texas purchased 100 acres of land which comprise part of the present station and subsequently an additional 152 acres was acquired so that the present station consists of 252 acres.

During the early years an important phase of the work consisted of testing crops recently introduced from foreign countries and this early work resulted in the introduction of Sudan grass and the grain sorghums Hegari and Feterita and in the distribution of Dwarf Yellow milo.

In common with all others, this station is collecting reliable information on the proper procedure in crop production and soil management. Varietal and cultural experiments are being made with all the important crops. Some attention is being devoted to vegetables and fruits for production in home gardens and orchards and to ornamental plantings of trees and shrubs.

The unique feature of the work at this station is the investigations under way with sorghums. The most complete nursery of both forage and grain types of sorghums in America is maintained at this point. An intensive study of sorghum inheritance is under way and the production of new and superior varieties is the aim of an inclusive plant breeding program.

Cotton Experiments

Cotton Variety Test: Production in 1938 was in the neighborhood of one-half bale to the acre. As is usually the case, the shorter staple and relatively early varieties produced the greatest yield. For the five-year period ending in 1938, Western Mebane 140, Jumbo, Western Mebane 141, Half and Half, and New Boykin have greatest productions in the order named. There is at present in this area a decided tendency to plant less acreage to cotton of short staple and greater acreage to varieties of longer staple, particularly Acala. This shift to varieties that will produce a staple of an inch or more will not prove profitable unless the present discrimination against short cotton continues in the years to come.

Date of Planting: For the fifth consecutive year drought conditions existed during the month of August. The last effective rain that had an

influence on the yields of cotton occurred on July 18. Even under these circumstances and in the absence of an infestation of flea hoppers, the late or June planting produced more cotton than a May planting. The April planting failed to come to a stand. Over a nine-year period the actual average yields from May and June plantings are respectively 224 and 223 pounds of lint to the acre. In individual years there have been considerable differences in yields between May and June plantings but in different years the differences have been in opposite directions which brings the averages of a number of years very close to the same figure.

Control of the Cotton Flea Hopper: Except for drought this insect probably influences the production of cotton in this area more than any other factor. There was an infestation of considerable proportion in August 1938 but any squares saved by control measures were lost from drought about blooming time in September.

Cotton Breeding: Western Mebane 140 and 141, the product of selection at this station during past years, have continued to produce well and are being distributed. Ordinary progeny row selection is being used to maintain the purity of the strains. In addition to this work, selections are being made in the progeny of a Lankart x Mebane strain and selections made this year in some F₄ rows are promising from the standpoint of length and character of staple and yield.

J. R. Quinby.

Experiments with Corn

Corn production, on account of favorable moisture conditions in the spring, was the best in many years. The outstanding variety in point of yield was Golden June which produced 37 bushels to the acre. The parent variety, Mexican June, produced 27 bushels to the acre.

Breeding work with the Golden June variety continued with the intention of improving grain color. The grain color has been greatly improved in three years and the color is now almost as deep a yellow as that of popular varieties of Dent corn.

J. R. Quinby.

Experiments with Sorghums

(In cooperation with Bureau of Plant Industry, U. S. D. A.)

Yields in 1938 were very good and in a number of cases were extremely high. There was a favorable early season and some of the highest yields ever recorded at this station were obtained from an April planting. Texas milo 276, one of the Pythium Root-rot resistant strains, produced 73.4 bushels per acre from a planting made on April 21. As in 1937, milo showed its old-time superiority in grain yield after many years of poor yields due to the disease. The use of Blight Resistant strains, of course, accounted for this condition. Averaging the results of both April and June plantings, milo produced 61 bushels to the acre; kafir, 28 bushels;

Hegari, 32 bushels; Spur feterita, 38 bushels; and Wheatland, a combine type, 37 bushels. Forage yields of Hegari, Sumac, and Honey for the same plantings were, respectively, 3.63, 3.92, and 5.19 tons per acre air-dry.

Date of Planting: During the past five years average grain yields of seven representative grain sorghum varieties from April, May, and June plantings were 22.9, 21.8, and 20.8 bushels to the acre. Corresponding forage yields of five sorgo varieties were 2.75, 3.05, and 3.15 tons air-dry.

Yield of Pythium Resistant Strains: The Pythium Root-rot fungus was not as virulent at Chillicothe in 1938 as in 1937. Nevertheless, there was considerable difference in yield of grain between resistant and susceptible strains planted on infected soil. From such a planting made in May, the yields were as follows: Texas milo (resistant) 50 bushels and milo T.S. 670 (susceptible) 26 bushels; Early White milo (resistant) 36 bushels and Early White milo (susceptible) 25 bushels; and Darso 28 (resistant) 41 bushels and Darso (susceptible) 23 bushels.

Sorghum Breeding: A further effort was made this year to identify the best of the original 800 selections of milo that are resistant to the fungus *Pythium arrhenomanes*, the organism that causes Pythium Root-rot or Milo Blight. At the end of the season it is believed that the best half-dozen strains have been recognized and the seed of a single superior strain will be put into the hands of Certified Seed Growers and other interested farmers for planting and increase in 1939.

There are many objectives in a rather inclusive sorghum breeding program but essentially the program consists of putting desirable characteristics into the common, adapted varieties. The production of yellow seeded feterita, kafir and Hegari is one aim and of a palatable grain sorgo is another. Also a straight-headed milo type is being worked for.

Sudan Grass Breeding: The work of obtaining a sweet-stemmed, juicy, sudan grass of distinctive seed color is progressing satisfactorily. As only one generation a year can be grown and the entire process of getting the desired combination of characters will take eight or ten years, it is still three or four years until seed of the new strain will be ready for increase by growers.

Hybrid Vigor in Sorghum: A paper on male sterility in sorghum was published in 1937 and in that paper it was pointed out that three requirements need to be met before hybrid sorghum can become a commercial reality. It will be necessary to devise effective means of getting good sets of seed with wind-blown pollen; it is desirable to discover closely linked characters so that male sterile plants of the female line can be readily detected previous to time of blooming, preferably at the time of thinning; and lines must be found or produced that will yield maximum vigor in the F_1 generation without sacrificing dwarfness or reasonably early maturity.

The work in 1938 consisted in getting the male sterile character into a dwarf line that has long and feathery stigmas as such a female parent will be necessary to insure good sets of seed. The male sterile character has been found to be linked with genes for awns and two seedling chlorophyll deficiencies, the cross-over values being as yet undetermined. Crosses were made involving 47 strains as parents and it is believed now that the varieties from which the best parents will come are known. It will take a number of years to solve all of the problems in connection with the production of hybrid sorghum but the work of each year brings the idea closer to reality and progress made in 1938 was all that could have been hoped for.

Inheritance Studies: This work which comprises one of the major activities at this station is resulting in an accumulation of knowledge of the genetics of sorghum that is contributing to the breeding program with sorghum in this as well as other states. The inheritance of about 50 character pairs has already been worked out and reported. A part of the work reported under "Inheritance Studies of Sorghum" in the section on Agronomy in this publication is being done at this station and will not be repeated here.

The linkage relations of three monofactorial characters in sorghum were calculated from the coupling phase of F_2 and F_3 populations totaling 2,091 plants. The characters and factor symbols are juiciness of stalk (Dd), seedling stem color (Rs rs), and purple plant color (P p). The order of the genes with approximate crossing over per cents was found to be D (10.9) Rs (16.4) P.

The gene for male sterility was found to be located on the same chromosome as the genes for awns and for two unreported chlorophyll deficient types, but the order of genes and cross-over percentages have not been determined.

J. R. Quinby, J. C. Stephens.

Small Grain

(In cooperation with Bureau of Plant Industry, U. S. D. A.)

Yields of wheat were in the neighborhood of twenty bushels to the acre. Chiefkan, a new beardless variety of Blackhull parentage grown for the first time at this station in 1938, produced the greatest yield, being very slightly higher in production than Kanred, Tenmarq, Blackhull, and Turkey. Over a period of years Kanred, Turkey, Blackhull, and Tenmarq have almost the same average yields.

An extensive wheat nursery was grown at this station for the first time. Strains that have resulted from breeding work at the Denton station during recent years were grown. This particular kind of work with wheat will be continued.

A winter barley nursery was grown also and the new barley varieties that have resulted from breeding work at Denton were considerably above the common barley varieties in yield. One of the Denton selections, the Smith variety, will be increased in 1939.

J. R. Quinby, J. C. Stephens.

Soybeans

(In cooperation with Bureau of Plant Industry, U. S. D. A.)

Five hundred and twenty-six varieties and strains of soybeans introduced in recent years from Manchuria and not previously grown in the Southwest were obtained from the Division of Forage Crops and Diseases of the Department of Agriculture and planted in nursery rows. As regards maturity there were early, mid-season, and late varieties. The early part of the season was relatively favorable but the latter part of the season was unusually dry so that a good reading was not had on the mid-season and late varieties. Although the results were more encouraging than those of previous years, the maximum yield of beans was less than 700 pounds to the acre. It is barely possible that among these new varieties one or two will be found adapted to this area which is badly in need of a crop of this sort.

J. R. Quinby, J. C. Stephens.

Ornamental Plantings

The plantings of trees and shrubs on the station include 131 species, most of which are well adapted to this area. In 1938 an additional 80 species were set out in an adaptation test and undoubtedly species now unknown to nurserymen and the public in general will come into use.

J. R. Quinby.

SUBSTATION NO. 14, SONORA

Substation No. 14 is located in Edwards and Sutton counties and comprises 3461.6 acres. The latitude is 32 degrees north and longitude 100 degrees west; the elevation is approximately 2,400 feet above sea-level. The average annual rainfall over a period of 20 years is 24.66 inches. This year shows 4.2 inches less than average. Sixty acres are in cultivation for the growing of feed crops while the balance is used for grazing purposes.

The station was established for the purpose of serving an extensive area known generally as the Edwards Plateau region, where livestock is the predominating agricultural resource. Sheep, goats, and cattle are the principal livestock of the region. This region produces the great bulk of the sheep produced in Texas, which ranks first of all the states in the number of sheep and the quantity and quality of wool produced.

The region also produces the great bulk of the Angora goats, producing 86 per cent of the nation's crop of mohair.

Studies in diseases of livestock, particularly the diseases of sheep and goats, constitute part of the station's activities, inasmuch as these occur under range conditions where, unlike other sections, loose herding is quite generally practiced. Another part is the study of inheritance of desirable and undesirable characters in sheep and goats. The study of external and internal parasites affecting livestock is also included. Other problems relate to the study of the forms of vegetation that make up the range feed value, the number, diversity, and occurrence of these different species, and the sequence in which they occur and contribute to the total carrying capacity of the range.

Cultivated Crops, Shrubs, Flowers, and Vegetables

Sixty acres of land are in cultivation for the production of feed for livestock. Sorghums constitute the main crop. This year approximately 11,000 bundles were harvested and stacked. In addition a trench silo 80 feet long by nine feet deep by nine feet wide was dug and filled with feed cut in September. Also the upright silo at headquarters was filled. The two silos hold about 200 tons. The silage will be utilized during the lambing and kidding operations or preserved until more adverse range conditions exist. Records for feed crops planted here show excellent yields four years out of six.

No experimental work is done with vegetable gardens, but the residences on the station have been able to produce early spring and fall products of radishes, spinach, onions, beans, beets, carrots, okra, turnips, and potatoes. Tomatoes are invariably killed out by a disease believed to be wilt.

The most satisfactory flowers grown here seem to be sweet peas, zinnias, chrysanthemums, various bulb plants, morning glory, and castor beans.

The introduced shrubs on the station, including privet, arborvitae, juniper, cypress, and Nandina, have grown satisfactorily and have greatly improved the landscape. The planting of yucca, cacti, senecia, and Huajillo, which are native, have been well established in some of the yards. More native shrubs, such as rosin bush and rubber plants, have been planted. Two of the rosin bushes died from root rot this year. Two fig trees irrigated have produced abundant crops of fruit for several years.

W. H. Dameron.

Prickly Pear Eradication

The results of the experimental work done with prickly pear eradication in 1933, 1934, 1935, and 1936, have been compiled in manuscript form. It will be presented for publication soon.

W. H. Dameron, H. P. Smith.

Spineless Cactus (*Opuntia Ellisiana*)

Our work this year with this plant was to test its usefulness on bitterweed range. We pastured 200 head of sheep on four acres from December until March, and let them have access to a one-section pasture heavily infested with bitterweed. The sheep consumed the pear ravenously and without waste. This seemed to appease their appetites for something green and succulent, with the result they did not eat any bitterweed during the bitterweed season. It seems that spineless cactus to be grazed by sheep may be of much value in bitterweed areas.

W. H. Dameron.

Bitterweed Control Studies

On Station Lands:

Good progress has been made at this station in the past seven years in decreasing bitterweed infestation by reducing the stocking rate from 64 units to 50. Grass cover has replaced bitterweed about 100 per cent on favorable grass growing areas, but the old lake beds and depressions remain covered predominantly with bitterweed. In an effort to improve these areas they were sown to Italian Rye grass in the fall of 1937. It germinated to a good stand and the moisture conditions were very favorable for its growth. The result was that all areas devoid of grass turf produced an excellent quantity of valuable forage for grazing instead of a solid cover of bitterweed.

Most of the Rye grass was planted in front of or behind a disk harrow which was used to prepare a seed bed. This amount of soil preparation seemed to be satisfactory for planting the Rye grass and was of much value in killing bitterweed seedlings that had germinated before the Rye grass was planted. Some Rye grass was sown on grass turfed areas for comparison with bitterweed hazard areas. The production of forage was very low on the turfed areas.

It was observed that Rye grass must be protected from too early grazing and then periodically for it to produce forage satisfactorily for grazing purposes, on bitterweed range. It germinates more quickly and grows more rapidly than bitterweed under favorable conditions, thus enabling it to crowd out the weed. The grass will not produce a seed crop if grazed excessively too long in late spring.

Another attempt is being made at this station to increase desirable winter forage and decrease bitterweed by deferred grazing. In February 1937, permanent meter square quadrats were staked off in Pastures E and I where the vegetation on the quadrats was charted. Pasture E was then vacated and remained so until June of that year, while Pasture I remained stocked as usual. Subsequent chartings of the vegetation on the quadrats were made periodically until the vegetation had matured and produced seed crops which was in June. The same practice was followed for both

pastures in 1938. Eighteen different varieties of plants, winter and spring growing were recorded during the February and March chartings in the two pastures. Most of those in Pasture E matured and made seed crops while those in Pasture I disappeared as they attained grazing size.

The comparative results of the early spring chartings for three of the most prevalent plants per acre are as follows:

	1937 Pastures		1938 Pastures	
	E	I	E	I
Bitterweed.....	780.071	246.867	1,007.703	225.585
Plaintain.....	84.987	76.893	368.277	16.188
Astragalus.....	56.258	28.329	149.739	44.517

The bitterweed shows some increase in Pasture E in 1938 over 1937 while in Pasture I it showed a small decrease. Perhaps the period of rest for Pasture E had something to do with this or it may be that a heavier cover of winter annuals on the ground, which require considerable moisture, tends to prevent or delay grass growth during the spring and early summer. More study is being directed along this line.

W. H. Dameron and V. L. Cory.

On University of Texas Lands

(In cooperation with University of Texas)

The University of Texas owns approximately 2,000,000 acres of grazing land in Southwest Texas which is operated solely on a cash rental basis to stockmen for grazing purposes. In some areas this land has become heavily infested with bitterweed the same as numerous ranches privately owned. It is a problem of common interest to all the property owners and operators to know how to cope with this encroachment of bitterweed and produce a living from the land.

Since this problem is becoming more and more serious from year to year by the spread of the bitterweed menace and in that it threatens to involve all of the ranching area of the State, a cooperative project on range management studies was set up on 3,160 acres of University land between Ozona and Barnhart, Texas, during the spring of 1938.

This range is about average so far as former range abuse and present noxious plants are concerned. It is about typical of some three to four million acres of flat to rolling country which surrounds it. The average annual rainfall is about 20 inches. The soil is mostly deep and fertile. The vegetative cover consists mostly of buffalo, mesquite and tobosa grasses. Mesquite bushes and prickly pear constitute the shrubs. There is a fair variety of forbs but the quantity is quite limited. The only weed of any consequence or concern is bitterweed (*Actinea odorata*).

The area was divided into fifteen pastures ranging in size from 84 acres to 600 with permanent water in each one. Each pasture has had a complete survey and charting made of all soil types. The vegetation has been checked likewise, and permanent locations set up for periodic chartings as the work progresses.

The carrying capacity of the area was set at 40 units per section to begin with, subject to being increased later if improved conditions of the range will permit. A unit is considered as one cow or seven sheep.

The specific pasture management is as follows:

- (a). Pasturing twenty cattle only, continuously, (320 acres).
- (b). Pasturing twenty cattle only in alternate pastures (160 acres each). The object here is to determine the advantage, if any, in periodic rests of pastures with straight cattle in controlling bitterweed. Also to study comparative production of the cattle.
- (c). Pasturing 140 sheep only continuously, (320 acres).
- (d). Pasturing 140 sheep only in alternate pastures (160 acres each). The object here is to compare the production and type of vegetation with Pasture C, as well as with A and B, also sheep production records.
- (e). Pasturing 10 cattle and 70 sheep together on same tract continuously, (320 acres).
- (f). Pasturing 10 cattle and 70 sheep together alternately on two pastures (160 acres each). The object here is to compare the type and production of vegetation with F as well as with all the other pastures. Also complete production records for the sheep and cattle.
- (g). Three pastures for deferred grazing with sheep and cattle rotated each three months. This gives each pasture six months rest during the year and will require four years to complete the cycle on seasons.
- (h). Study vegetation on tract excluded entirely from grazing. This tract to be compared with all the other pastures and systems of management for disappearance of bitterweed and increase of desirable forbs.
- (i). Study plant introduction on bitterweed hazard areas as compared to recovery by native plants. Winter growing grasses and legumes have been selected for this for the reason that bitterweed grows best during the winter. Also, native winter growing forbs have been greatly diminished by continuous and excessive stocking.
- (j). Mechanical destruction of bitterweed on hazard areas where it seems advisable for comparison with other means of control or reclamation.

(k). Uncontrolled grazing in a representative pasture for comparison with all other pastures.

(l). A reserve pasture (600 acres) for the purpose of providing flexibility in the rate of stocking on the experimental pastures. Most of the plant introduction work will be done in the reserve pasture so that if the sheep have to be taken out of some of the others on account of bitterweed or lack of desirable feed we can perhaps avert a feed bill.

The livestock purchased for the study was 500 well bred Rambouillet yearling ewes, and 60 head of well bred two-year-old Hereford heifers. Weights of the livestock were taken as they were distributed to the various pastures. They will be weighed periodically, spring and fall, for the duration of the study. Production records of wool, lambs, and calves will also be kept for all the different systems of management.

Forty acres for feed crop production was set up and cultivated this year. Seventy-two tons of sorghum silage which is excellent feed on bitterweed range was harvested. Also four tons of maize heads.

This study is set up to extend six to ten years, or longer if necessary to procure conclusions on the behavior of both the livestock and the range vegetation.

W. H. Dameron, V. L. Corey, R. L. Hensel,
and E. C. Compton, (University of Texas).

Maintaining Sheep on Bitterweed Range

Many feeds, and different combinations of feeds, have been given to sheep on range infested with bitterweed in an attempt to avoid bitterweed poisoning. We have failed by using cottonseed meal, cottonseed cake, sorghums in the bundle and chopped mixtures of cottonseed meal and salt plus oyster shell and alfalfa hay.

This year 285 head of our grade sheep were kept in Pasture C where they had access to four acres of spineless cactus from December 23, 1937, to March 15, 1938. The gate to the cactus field was kept open so the sheep could enter at will. They browsed on the cactus extensively. It seemed to satisfy their craving for something succulent, with the result that we did not experience any bitterweed poisoning among these animals during this time.

Even though the cactus was browsed down to the stumps there was very little waste and the cactus put out a good growth of new slabs during the summer.

Another feed with which we had success on bitterweed range during late winter and early spring was sorghum silage. It was fed to registered sheep in Pasture D from the latter part of February through March. There was considerable bitterweed growth in this pasture during the time of

this feeding period, but bitterweed poisoning was not experienced among the animals fed.

W. H. Dameron and O. L. Carpenter.

Animal Breeding Investigations

This station maintains a flock each of registered sheep and goats used primarily for studies on:

- (1). Inheritance of Polled character in Fine wool sheep.
- (2). Inheritance of the Ridgling characteristic in goats.
- (3). Inheritance of skin folds on Rambouillet sheep.
- (4). Inheritance of type in Angora goats.
- (5). Relation of age of animal to fineness of wool and mohair.
- (6). Determining grades and shrinkages of wool and mohair.

There were 17 registered Rambouillet rams, 208 registered Rambouillet ewes, 26 bred corriedale and cross-bred ewes, 186 lambs, 45 yearling ewes, 59 yearling rams, 5 registered Angora bucks, 220 bred registered Angora does, 107 Angora kids, 54 Angora buck yearlings, and 54 Angora yearling does involved in the studies on these projects this year. Individual body, physical and fleece descriptions were recorded on all of these sheep and goats this year.

In addition to the registered sheep, 163 bred purebred Rambouillet ewes, 101 lambs, and 60 yearling ewes are maintained for sire testing purposes and miscellaneous feeding.

W. H. Dameron.

Livestock Disease Investigations

Hard Yellow Livers of Sheep and Cattle.

Field investigations showed that this disease existed among sheep on many ranches in parts of Glascock, Reagan, Upton and Midland counties. No new cases developed during the year under review.

Vegetation surveys, conducted several times during the year on many of the affected ranches deepened the suspicion that the poisonous weed, *Senecio longilobus*, played an important part in causing the condition. Significantly, this weed grew abundantly on the range during the spring and early summer of 1937, when the disease was prevalent, but made only sparse growth during the present year when no new cases of the disease developed.

Altogether 27 head of experimental animals were fed different quantities of *S. longilobus* and then held for observation.

Nine animals were transported to a ranch in Glasscock County and fed varying amounts of the fresh green plant during April, May and the first ten days of June. Of these, three sheep consuming three per cent body weight per feed died after eating approximately 66 per cent of their body weights in 77 consecutive days, showing typical lesions of acute *S. longilobus* poisoning. One animal died after consuming 35 per cent body weight in 35 days at the rate of one per cent per feed, and showed acute lesions at autopsy. One animal, which had consumed some 68 per cent of its body weight at rate of two per cent per feed during 77 consecutive days, died following an exploratory laparotomy. Macroscopic cirrhosis was noted at autopsy and, microscopically, cirrhosis accompanied by enlargement and degeneration of the liver cells comprised the lesions. The remainder of this group, four sheep, were turned into the pasture shortly after their return to this station on June 12, 1938. At present three of these animals are in normal clinical condition, while one sheep, which consumed 58 per cent of its body weight at the rate of two per cent per feed during 77 consecutive days, was found recumbent in the pasture two days before the end of the year. The animal presents a typical clinical picture of hard yellow liver disease.

Eighteen sheep and two goats were fed *S. longilobus* at this laboratory. Water loss of the weed was calculated, and allowance made in figuring the amount fed each animal.

One sheep consumed 122 per cent of its body weight of weed at the rate of one per cent body weight per feed, and died in 148 days; autopsy revealed advanced cirrhosis, liver cell enlargement and degeneration.

One sheep, after consuming 113.5 per cent body weight at the rate of .75 per cent of its body weight per feed, died on the 240th day. Macroscopically, cirrhosis was noted in the liver, while the microscopic lesions were practically the same as those seen in field cases of hard yellow liver.

One animal ate 62 per cent of its body weight of weed at the rate of .25 per cent per feed during 248 days and died following an exploratory laparotomy. Gross cirrhosis was noted at autopsy, and microscopic river lesions were indistinguishable from those seen in field cases of hard yellow liver disease.

One ewe consumed five per cent of its body weight of weed in two feedings of two per cent and three per cent respectively within 14 days. She was very sick for about a month, gradually recovered, and when slaughtered 102 days after the last feeding showed advanced liver cirrhosis. Microscopically the lesions were exactly the same as those noted in field cases of hard yellow liver disease.

One ewe, force fed 1.5 per cent of its body weight of weed in one dose, was very sick for about a week, recovered for approximately 30 days, and then suffered a relapse. The wool was "taggy" and dead in

appearance, and the animal presented clinical signs of abdominal "dropsy." This sheep, dying on the 47th day after weed feeding, showed a cirrhotic liver together with an advanced "water belly," the abdominal cavity containing approximately five gallons of clear, straw-colored fluid.

The rest of the experimental animals fed *S. longilobus* are still under observation.

I. B. Boughton and W. T. Hardy.

Serum Calcium and Inorganic Phosphorus of Sheep.

Serum calcium and inorganic phosphorus determinations on sheep on four widely separated ranches were run at monthly intervals for over a year with the sheep being kept under range conditions. In the results obtained the amount of these minerals in the blood did not fall below normal and the ratio of one to the other was well within normal limits. A seasonal variation in each group, depending upon the green or dry condition of the vegetation was detected but at no time did any of the animals show clinical evidence of a deficiency of either of these minerals.

I. B. Boughton.

Soremouth (Contagious Ecthyma) of Sheep and Goats.

Dried, powdered soremouth scab, stored in a clear-glass, stoppered flask in the light at room temperature for 73 months was not potent when inoculated into the scarified skin of a susceptible lamb. This virus was potent after 61 months storage.

The rest of the work on this project was confined to the production, testing and shipment of vaccine.

I. B. Boughton and W. T. Hardy.

Stomach Worms (*Haemonchus contortus*) in Sheep and Goats.

The studies of the longevity of *H. contortus* larvae on the range were concluded.

Two plots, fenced and ditched in 1934 and tested at intervals to determine presence or absence of larvae and then infested by grazing infested sheep therein, were tested with parasite-free lambs during the present year and found free of larvae.

These studies have shown that *H. contortus* larvae will remain viable for at least 22 months on the open range in West Texas.

A parasite-free lamb was drenched twice, with 9,350 infective larvae each time, during a three-day interval. Ten months after the last drenching this animal's feces showed less than 400 eggs per gram and the animal was placed in an infested pasture. The animal remained in excellent condition and was released as healthy three months later.

A parasite-free lamb, injected with 270 milligrams of a suspension of dried powdered *H. contortus*, was still susceptible to artificial infestation with infective larvae two months later.

Six parasite-free lambs, drenched with 660 infective larvae each, had virtually recovered from the infestation within six months. Six months later they were turned into an infested pasture. Two of the animals died of intercurrent disease, and the four remaining animals continued healthy and were released after 13½ months' exposure.

A one-year-old parasite-free lamb, turned into an infested pasture, showed a mild infestation with *H. contortus* five months later. The animal remained healthy when released 13 months later.

A parasite-free lamb was drenched with 4,200, 4,285, 5,200, 4,200, 5,040 and 7,200 infective larvae respectively on six consecutive days, and then given orally 7,328 and 15,900 infective larvae respectively 20 and 28 days later. This animal did not exhibit clinical signs of infestation during the next eight months. Turned into an infested pasture at this time, it continued in excellent condition for the succeeding 106 days, when it was returned to the barn, drenched with 18,750 infective larvae and held under observation for eight months. During this time the animal remained healthy, was returned to an infested pasture, and at present, seven months later, remains in excellent condition.

A parasite-free lamb was drenched with 115,390 infective larvae in nine separate doses during 34 consecutive days. Definite clinical signs of infestation developed in about 60 days. Spontaneous recovery occurred in the next ten days. Eleven months after the last dose of larvae this animal was turned into an infested pasture where it has remained in excellent condition for 31 months.

A five-month, parasite-free lamb, drenched with 45 mature, viable *H. contortus*, showed positive fecal examinations for the next 11 months. At this time the animal received 18,000 live, infective larvae orally, peak egg production developed in two months and decreased to less than 400 per gram of feces within ten days. The animal, in excellent condition, has been running in an infested pasture for the past 19 months.

H. contortus larvae, grown in sheep manure in an air-tight Mason jar for nine months in the dark at room temperature, were viable and infective when administered orally to a parasite-free lamb.

I. B. Boughton and W. T. Hardy.

Infectious Entero-toxemia of Lambs and Calves.

Prevention of this malady, by injection of pregnant ewes about one month prior to lambing with a zinc chloride toxoid of the causative organism, *Clostridium Welchii*, Type D, was attempted in both pen and field experiments.

Pen Experiments.

Eight lambs, injected subcutaneously with 3-cc. doses each of the ZnCl₂ toxoid developed an active immunity within 27 days. This immunity declined to less than one-fourth unit antitoxin per cc. of blood serum within 76 days after the injection, and the animals were again given 3 cc. each of the toxoid subcutaneously. The immunity gradually increased and at the time of release, nine months after the second injection, amounted to approximately ten units per cc. of blood serum.

Seven lambs, injected at the same time as the foregoing animals with 3 cc. each of a stannous chloride toxoid of the causative organism, also showed a temporary immunity following the first injection. The immunity, induced following the second injection of toxoid 76 days after the first treatment, gradually increased, and at the time of release from the experiment, nine months after the last treatment, amounted to about ten units per cc. of blood serum.

Seven lambs, injected subcutaneously with 3 cc. each of a potassium alum toxoid of *Cl. Welchii*, Type D, developed only a transitory immunity. A second injection, given 76 days later, induced an increasing immunity and at release, some nine months after the last treatment, the animals were carrying about ten units of antitoxin per cc. of blood serum.

Immunity tests of lambs injected with the supernatant fluid of the zinc chloride toxoid following the addition of ZnCl₂ solution, showed that no toxoid was left in this fluid, while a similar test with the supernatant fluid from the potassium alum toxoid showed that an appreciable amount of toxoid was left in this fluid.

Seven lambs, injected with 2 cc. each of ZnCl₂ toxoid of the organism, developed an active immunity which endured for the succeeding 4½ months, at which time the experimental animals were released.

Twelve lambs, injected subcutaneously with 2 cc. each of the ZnCl₂ toxoid of the organism, show between one-fourth and one-half unit antitoxin per cc. of blood serum five months later.

Ten pregnant ewes, vaccinated one month before parturition with ZnCl₂ toxoid of *Cl. Welchii*, Type D, developed antitoxin in the blood serum within one month after treatment. All of these animals lambled normally, dropping strong, healthy lambs.

Potency tests of the sera of lambs dropped by these ewes, made between five and eleven days after birth, showed appreciable amounts of antitoxin in the blood of each lamb. Tested at intervals for the next four months, the serum of each lamb still showed some antitoxin.

Check tests on the sera of seven lambs dropped by non-vaccinated ewes showed no antitoxin in the blood of three, and just about one-fourth unit per cc. in the blood of the remaining four animals.

Field Experiments.

In these tests the ewes were treated approximately one month before lambing time.

	No. Pregnant Ewes	Treatment	Lambs died Entero-toxemia
Ranch A.....	140	2 cc. each ZnCl ₃ toxoid...	2 (1.4 per cent)
	50	None. Controls.....	2 (4 per cent)
Ranch B.....	222	2 cc. each ZnCl ₃ toxoid...	1 (.45 per cent)
	600	None. Controls.....	4 (.67 per cent)
Ranch C.....	1,056	2 cc. each ZnCl ₃ toxoid...	None
	415	None. Controls.....	4 (.96 per cent)
Ranch D.....	615	2 cc. each ZnCl ₃ toxoid...	None
	230	None. Controls.....	6 (2.4 per cent)
Ranch E.....	1,709	2 cc. each ZnCl ₃ toxoid...	None
	5,000	None. Controls.....	1 (.)
	(Approx.)		

On several ranches in Sterling County 272 calves between two and three months of age were each injected subcutaneously with 2.5 cc. of a ZnCl₃ toxoid of *Cl. Welchii*, Type D, and 67 similar calves were left untreated as controls. Type D toxoid was used because a toxoid of Type A, which had been isolated originally from calves, was not available. No loss from entero-toxemia occurred either among the control or the treated animals.

In another similar field test, ten calves died among a total of 43 treated, while there was no loss among the 33 control calves. A flood following the July rains occurred in the pasture where the treated animals were kept, while no overflow took place in the control pasture. The disease appeared approximately two months following treatment, and about two weeks after the flood.

Six calves, sick from entero-toxemia, were treated with 3,500 units each of *Cl. Welchii*, Type D, antitoxin and recovered. In another outbreak 12 sick calves received 10,000 units each of the antitoxin; two died and ten recovered.

I. B. Boughton and W. T. Hardy.

Suspected Plants

Feeding trials of Globe Mallow (*Sphaerocoa coccinea*, var. *dissecta*), *Peganum mexicanum*, *Stephanomeria pauciflora* and the rain lily, (*Cooperia Drummondii*), were conducted with negative results. A sheep fed two per cent of its body weight of the bark of *Rhamnus caroliniana*, var. *mollé*, developed a transitory diarrhea, while two other sheep, fed the green leaves and the fruit of this plant, remained normal.

I. B. Boughton and W. T. Hardy.

Miscellaneous Work

Bonemeal and Salt Mixture Feeding Experiments.

Monthly determinations of the calcium and inorganic phosphorus in the blood serum of four cows, running on the range, with two of them receiving measured amounts of a 50-50 bonemeal and salt mixture, and the other two receiving measured amounts of plain salt three times weekly, showed no appreciable variation from the normal. The seasonal variations remained within normal limits. Each animal dropped a normal calf during each year of the four-year test. There were no significant differences in the birth weights and growth of any of these calves.

Cottonseed Meal and Salt Mixture.

Two aged ewes each consumed a total of 93,454 grams of salt (mixed with 289,362 grams of cottonseed meal) during 1392 consecutive days; the daily average intake of salt amounted to 67 grams per animal. These two animals are very thin, carry only a very little brittle wool, and have not conceived during the experiment.

Limberleg (?) of Sheep

Two ewes affected with a nervous condition resembling "limberleg" were secured from a ranch near Langtry and given large daily doses of Vitamins A, D and the B complex for 25 consecutive days without visible clinical improvement. Both animals were slaughtered, and heavy emulsions of brain and cord tissue were injected into two local healthy ewes. Fifty-two days later these animals remained normal.

I. B. Boughton and W. T. Hardy.

Range Vegetation

From the beginning, after the year or two necessary to become familiar with the plant species, notes were taken and species recorded, for the first several years giving the date when each species was first seen in bloom. It has been found that more than 500 species of plants grow at Substation No. 14. Of this number less than one-tenth, principally due to lack of abundance, are of economic importance as forage plants. In six of the pastures at Substation No. 14 a detailed census of the woody plants and a mapping of the thickets and other types of vegetation have been made on permanent rectangles, usually from 6-8 acres in area. In addition eight other rectangles in the horse trap, or Pasture G, were worked in a similar manner. Thus far 100 acres or more, the definite composition of the range, so far as woody plants are concerned, is recorded. Also an estimate of amount of area occupied by each species of woody plants, or by various types of vegetation, is tabulated and recorded. This work was done in 1926-1929, and has been reported previously in monthly reports. If deemed advisable subsequent work of a similar nature will show whatever changes may have taken place in the intervening years. The various

quadrat studies in the pastures of Substation No. 14 have been in connection with studies of the occurrence of *Actinea odorata*, the identity and the abundance of other forbs, and the species and abundance of other grasses. For the most part this work was instituted early in 1931, and previous reports have related progress of the work or results. There is known to be an encroachment of woody plants on the range. The data available indicate variations in vegetation from year to year depending for the most part on conditions of precipitation. Under moderate stocking of livestock the stand of grass tends to approach a level, the losses from droughts being recovered in periods of heavy rainfall. The occurrence of *Actinea odorata*, under similar conditions of stocking, likewise varies with climatic conditions, in a series of years tending to approach a level with a year of maximum occurrence followed by a year of minimum abundance, with a more or less progressive increase in number for some years to another high, when a similar course of events follows.

Morphology of the Bitterweed Head and Achene.

The progress made under this project consists in learning that the habit of the plant on reaching maturity of inflexing the involucre bracts to cap the head and securely protect and preserve the achenes until the head becomes soaked by rainfall or moistened by contact with damp soil and the involucre bracts open and the achenes become released from the head and gain a satisfactory condition for germination, is a normal adaptation of the plant for survival during unsatisfactory conditions for germination and growth of the young plants and not any abnormality due to insect infestation or otherwise. This adaptation is unique among its fellow members of the plant family known as the composites.

The Dissemination of Bitterweed Seed

As reported for the year of 1933 thirteen samples of wool were minutely examined for seed of range plants. These samples of wool came from a range heavily infested with bitterweed. It was found that approximately an average of four to five thousand seed to the pound of wool was present in these samples of wool from the neck, side, belly and legs of range sheep. The average of the thirteen samples was 82 seed of bitterweed to the pound of wool, with none in wool from the neck, and the greatest number in wool from the legs. It is concluded that individual achenes become so thoroughly imbedded in the wool that little probability exists that any other than a minimum of transportation to uninfested ranges takes place in this manner. However, the small capped heads could be so transported readily, but only rarely are such heads detached from the plant or picked up in the wool. In only two cases in the 13 samples were heads found, one being empty and the other containing seven achenes. Where run-off of rainfall is checked on a range infested with bitterweed the heads and achenes are deposited in lines and in general over areas where the run-off water is checked or held. In one such area a square inch not noticeably

showing any deposition of bitterweed heads or achenes, on close examination revealed 15 achenes. Next to dissemination by run-off waters, bitterweed is spread by becoming fastened to bits of mud that are picked up on the feet of animals or by the wheels of vehicles. When these bits of mud dry and become detached the seed may be in a new locality and frequently on higher ground. On many ranges this is the most serious form of dissemination. Several instances are definitely known where bitterweed plants have been found on overflowed lands of hitherto uninfested ranges, but always the original infestation is slight, and with prompt attention readily destroyed.

Germination and Longevity of Bitterweed Seed

Laboratory tests of germination of bitterweed seed have been conducted by the Division of Agronomy at College Station. In a general way, laboratory germinations are much inferior to the apparent germination on the range. Presumably seed stored in a laboratory retain vitality longer than when stored outside. Two lots of seed were scattered on a ground surface bared of vegetation and surrounded by a frame which was screened to prevent introduction of other seed of plants from the air or by run-off water. The one lot of heads, with involucre bracts not strongly inflexed, disintegrated badly in one year, while the other lot, the one with involucre bracts tightly capping the head, remained in whole condition a year longer. The sixth year there was some germination of bitterweed from both lots of heads, but in the seventh year, early in 1938, there was germination only in the lot of tightly capped heads, and this was only of seven plants. As the conditions of storage, high, well-drained ground freed from vegetation and kept free of accumulation of other organic matter, was favorable to preserving the viability of the bitterweed seed, it is concluded that under favorable conditions seed from tightly capped bitterweed heads retain a small amount of viability for as long as seven years. Early in 1938 the ground surface was completely disturbed by moles, and the test abruptly concluded.

Hard Yellow Livers in Sheep and Cattle

Search for *Senecio longilobus* on certain ranches, was without success. All these ranches had suffered losses from hard yellow livers in sheep. On the other hand this plant was found in abundance on ranges in other localities and sheep grazing on such ranges have not been affected with this trouble. Certain important facts in this connection have not yet become available.

Control of Bitterweed on the Range

This project applies to work undertaken in 1938 on the Range Experiment Station south of Barnhart. Five counts of the vegetation were made

in each of the 15 pastures. The counts in the early part of the year showed a heavy infestation of bitterweed in most of the pastures, while the count in December tallied only two plants of bitterweed in 8,600 counts. Thus for 1938 there is scarcely any infestation of bitterweed at the close of the year.

Additional Bitterweed Control Work

In western Schleicher County eight quadrats of one-fourth acre each were located in a trap rather heavily infested with bitterweed in 1937. In the four pairs of quadrats one of each pair was fenced to form an enclosure, and permanent meter quadrats located in each of the larger quadrats. The effect of absence of grazing on the occurrence of bitterweed is to be noted in these quadrats. There was practically no bitterweed in any of these quadrats in 1938, hence no results were gained.

Work is being done on a ranch in Sutton County where livestock are shifted twice yearly by counting vegetation at times of these shifts. Whether the methods of stocking have any influence on the control of bitterweed or not are not yet indicated. It may take several years before obvious results are gained.

In adjoining pastures of Substation No. 14 the effect of deferring grazing for the first half of the year as contrasted to continuous grazing is being studied in pastures E and I, which adjoin each other on the north side of the Station Ranch. The studies are made by estimates of the stand of the various species of plants in permanent meter quadrats located on a diagonal line of each pasture. The expectation is that deferred grazing will show a marked increase in several of the forbs that are good forage plants, and the hope that these forbs will provide competition for bitterweed to the extent that it will be held in check. This year marked the completion of one year of the test, and the data indicate that all forbs increase in abundance under deferred grazing, and that bitterweed is no exception. That is to say that the results of the first year show that the other forbs cannot in one year increase enough to offer effective competition to bitterweed. The test should be continued for as much as a period of five years before accepting the indication as a factual result. At the present time deferred grazing the first half of the year gives indication of being ineffective in the control of bitterweed.

V. L. Cory.

Insects Affecting Animals

(In cooperation with Bureau of Entomology and Plant Quarantine,
U. S. D. A.)

The year's work proved most promising in that five satisfactory wetting agent formulae have been developed. These formulae are: 418-KNO; 373-DJO; 399-GKO; 417-KLO; 342-ALO.

These wetting agents when mixed with sulphur are capable of wetting the sulphur in calcium carbonate, sodium magnesium sulphate waters, and will also tolerate gypsum and sodium nitrate waters.

Rotenone added to sulphur apparently stimulates or hastens the kill of goat lice.

The red and the blue cattle lice are easily killed by the use of wettable sulphur, 10 pounds to 100 gallons water, on an eleven-day interval basis. The short-nosed ox louse is not readily killed in the arsenical cattle dip, wettable sulphur dip, hot lime sulphur dip testing .20 per cent polysulphides, nor ordinary creso dips. Hot lime-sulphur dip at a temperature of 110° F. and .22 per cent polysulphides will apparently kill all lice present.

The first instar of *Oestrus ovis* larvae when introduced into the eye of sheep may produce considerable irritation and produce swelling of the eye, but the larvae are soon killed and washed out by the tears.

Oestrus ovis flies were observed active during the months of August, September, October, November and January. Observations were not made in December, February and March.

Out of three sheep examined, 15 *Oestrus ovis* larvae were found dead in the sheep's head, three of these were in the blind pouch of the superior maxillary sinus.

The following oestrocides look promising: namely, DiN. O. H. P., Amine X, Xylol and Chloroform, but when given to live animals the results were not so promising.

The pupal emergence period of *Melophagus ovinus* may vary from 21 to 27 days.

Outside of the *stable fly*, the electric fly trap installed in the Screw worm fly house did not give promising results so far as the primary Screw worm fly, *C. Americana*, is concerned.

O. G. Babcock (Bur. Entom. & Pl. Quar.).

SUBSTATION NO. 15, WESLACO

Substation No. 15 is located in the Lower Rio Grande Valley near Weslaco. The farm consists of 100 acres of improved land, lying about midway between the cities of Weslaco and Mercedes on the main Valley highway. The four counties forming the southernmost part of the State are served by the Valley station. Of these counties, Hidalgo ranks first in the United States in acreage planted to grapefruit. It also ranks near the top in cabbage and tomato production, while Cameron County ranks second in potato production and very near the top in cabbage and tomato production. Willacy County ranks high as an onion producing region, and with the development of facilities for irrigation, will become increas-

ingly important in the production of citrus fruits, vegetables, cotton, and feed crops. The rapid expansion of the canning and processing industries in the Lower Valley region has increased the demand for information relating to such subjects as crop adaptability, limiting factors in crop production, plant nutrition, and the control of insect pests and diseases.

Experiments with Citrus Fruits

Grapefruit Production Investigations: Seedless varieties of grapefruit are enormously productive under average Valley conditions, but old orchards tend to deteriorate unless the trees receive special cultural care after the twelfth or fourteenth year. Excessive salt accumulation in the root zone of the trees due to inadequate subsoil drainage and improper irrigation practice are two of the principal causes of early decline. Nutritional disorders due to deficiencies of organic matter, nitrogen, and other elements also cause older grapefruit trees to become unthrifty and unproductive. Deterioration diseases such as psorosis and heart rot gum disease are responsible for the early failure of trees which become infected during the early life of the orchard. Results secured in an 18-year-old Marsh grapefruit orchard indicate that the maintenance of soil fertility by the use of acid-forming fertilizer concentrates and large quantities of rough organic matter, and that keeping salt concentrations and soil alkalinity at safe levels by proper irrigation practice, are highly important in the management of aged grapefruit orchards.

Citrus Variety Adaptability Tests: Most standard varieties of citrus when grown on sour orange understocks are well adapted to conditions in this region. Navel oranges, as a class, Dancy tangerines, and King Mandarins, are the least desirable varieties because of their erratic behavior under Valley conditions. Seedless varieties such as Ruby, Pink Marsh, Marsh, and Little River grapefruit; and Hamlin, Joppa, Texas Navel, and Valencia orange, are the varieties recommended for commercial planting. Trees of Ruby grapefruit, Hamlin and Joppa oranges, and Algerian tangerines were unusually productive during the 1938 season. Yields from 12-year-old Hamlin trees averaged well above 800 pounds per tree, while yields from dwarf Algerian tangerine trees ranged around 600 pounds per tree. Promising new varieties in the station collection are the Perrine lemon, the Mineola tangelo, and the thornless Mexican lime.

Citrus Rootstock Adaptability Tests: Standard sour orange is so well adapted to Valley conditions that there is little justification for extensive rootstock investigations. An effort is being made to encourage Valley nurserymen to use superior strains of sour orange for rootstock purposes. Budwood and seed of tested and proven varieties of sour orange have been distributed. Observations covering a 15-year period justify the conclusion that trifoliate orange, Calamondin, citrange, grapefruit, shaddock, sweet lime and sweet orange are unreliable stocks for use in the Lower Rio Grande Valley. Sour orange is the most desirable stock, but Cleopatra

Mandarin and rough lemon may be useful on certain types of soil, especially where irrigation water is not available at all times. Triumph grapefruit, apparently an orange-grapefruit hybrid, is an exceptionally vigorous understock that may be useful for the propagation of weak growing varieties.

Citrus Fertilizer Tests: The results secured in a block of nine-year-old grapefruit trees and in a block of 18-year-old trees further substantiate the previously drawn conclusion that nitrogen and crude organic matter are the most essential parts of the citrus orchardists fertilizer program. Sulfate of ammonia because of its acid-forming properties is especially desirable for use in this region. Ten pounds per tree, per year, appears to be about the top limit for aged trees, and half this amount will be sufficient during a season when the set of fruit is abnormally light. There appears to be some justification for making two applications per season, one five pound per tree application prior to the blossoming season and an additional five pounds about May 1st if conditions appear to justify this additional feeding. Roughage such as sorghum hay is essential to the maintenance of production in old orchards.

Orchard Reclamation Studies: Citrus trees have great recuperative powers, unless the health of the tree has been impaired by some devitalizing disease such as scaly bark or infectious gum disease. Unfavorable soil conditions appear to affect the health of the trees, principally by upsetting the nutritional balance within the trees. Once these unfavorable soil conditions are corrected and adequate amounts of plant food materials are supplied, the trees will usually respond in a most surprising manner. Acid-forming materials such as sulfate of ammonia, sulfate of iron, and sulfur, when used in conjunction with bulky organic matter, will bring decadent citrus back into profitable production, provided the trees are reasonably free from infectious diseases that cause deterioration and provided the subsoil drainage is adequate. Sorghum hay applied at the rate of five tons per acre has given results in improving tree condition and fruit yields equal to those secured from a five-year treatment with 5-15-5 fertilizer, applied at the rate of one ton per acre, per year.

Pruning Wound Protectants: The infection of tree wounds with any one of several facultative, wood-rotting, parasitic fungi is one of the principal causes of early decline of citrus trees in this region. Poor pruning and tree surgery practices and the use of ineffective wound protectants are largely responsible for the widespread occurrence of infectious gummosis (heart rot) and psorosis (scaly bark) in Valley citrus orchards. The use of the rosin-bichloride-alcohol varnish, or plant safe carbolineum priming coats, followed by a weather-proof, protective coat of petroleum enamel or asphaltum-carbolineum wound dressing will disinfect tree wounds and protect them from wood inhabiting insects. The petroleum enamel, which is made from petroleum varnish (Rust-ban) 50 per cent Zinc oxide 48 per cent and yellow mercuric oxide two per cent; and the Asphaltic paint, made from pure asphaltum 50 per cent and phytonomic carbolineum 50 per cent are safe and effective weather-proof

wound protectants which will give perfect protection under most trying conditions. A two-coat method of treating tree wounds must be used during the growing season if perfect results are desired. Excessive sap pressure increases the difficulties encountered in adequately disinfecting and weather-proofing a wound where considerable areas of green wood are exposed. Asphalt emulsions are not effective as wound protectants when used alone, and many of the roofing cements which are used in tree surgery contain sufficient coal tar to cause excessive cambial development that might be considered carcinogenic.

Storage of Citrus Fruits: Toward the close of the 1937-38 fruit season several lots of grapefruit and lemons were placed in storage. Since desiccation is always a factor of importance in fruit storage and merchandising, three waxing treatments and several wrapping treatments were included in the tests. Most of the fruit was placed in an air-conditioned storage room to be held at 58°, but "leakage" from adjoining freezer rooms made it impossible to hold the temperature higher than 45°. Very satisfactory results were secured with Valencia oranges and with one lot of grapefruit that was harvested from an abandoned orchard. Grapefruit from properly irrigated orchards did not keep well in storage. One kind of liquid (emulsified) wax, which contained considerable quantities of ammonia, tended to reduce the losses due to decay, while the other wax treatment appeared to increase losses from decay. The wax treatments and the Cellophane and foil wraps were effective in preventing losses due to softening and shriveling. Even at room temperatures, during the summer season, Cellophane and foil wraps kept the fruit in perfect condition for a period of five weeks. Waxing alone was not nearly as effective as the moisture retaining wraps in preventing shrinkage. Where sound fruit is used and bruising is avoided, the holding of late oranges and grapefruit in air-conditioned storage appears to be entirely practicable.

Fruit Wrapping Studies: The production of Meyer lemons has become a commercial enterprise of considerable importance in the Valley, but the very thin skin of these otherwise desirable lemons makes them rather difficult to merchandise without excessive loss. The use of antiseptic and protective washes and the use of moisture retaining wraps will aid greatly in reducing losses due to molds and shriveling. The use of Cellophane, foil or heavy waxed wraps or crate liners will materially reduce shrinkage losses that occur after the fruit has reached the retailer.

Experiments with Vegetable Crops

Cabbage Variety Trials: The market preference for early truck crop cabbage is for a small (3- to 3½-pound) head, globular or flattened in shape and with several dark green wrapper leaves. The wrapper leaves of certain varieties do not adhere tightly to the head and are frequently lost in the handling the product receives during its journey to the consumer. Varieties such as Golden Acre and Midseason Market meet the

requirements as to quality, productive capacity and shape in a most satisfactory manner, but these varieties may lose their wrapper leaves in transit and must be sold as trimmed white cabbage. Some of the small varieties of the Dwarf Flat Dutch, Round Dutch, and Dwarf All Head types should become increasingly popular for sale in small sized containers.

Potato Fertilizer Tests: Rather extensive potato fertilizer tests were conducted on a block of clay loam soil near Los Fresnos, Texas, which is typical of a considerable area of land that is utilized in the production of potatoes during the spring season. No highly significant differences in yield were secured, except that the heavier applications of materials such as cyanamid tended to reduce yields, especially on one series of plats on relatively high land that undoubtedly received less water than the other series of plats. Nitrate of soda applied after planting gave slight but consistent increases in yield, while one of the complete fertilizers tended to reduce yields. On the better soils of this region that are well supplied with humus, fertilizer concentrates are probably less important factors affecting production than soil moisture, blight, and climatic influences.

Potato Variety Tests: Cameron County is one of the most important early potato producing areas in the United States. Practically all of the acreage is planted to the Bliss Triumph variety, and the unmerchantable grades from the spring crop are held in cold storage and used in growing a fall crop. The fall potato crop has been relatively unimportant because most of the crop is sold within the State and the demand for red-skinned boiling potatoes is definitely limited. Rather extensive spring and fall tests, conducted with certified seed of some of the new varieties, indicate that there is a place for these excellent potatoes in Valley horticulture. Chippewa, Katahdin, Warba, and Red Warba are the most promising varieties. Chippewa and Katahdin are especially desirable because of their high yielding capacity, excellent quality, and resistance to disease. The fall production of potatoes of this type should be encouraged.

Green Manuring Studies with Vegetable Crops: Land which grew summer catch crops of cowpeas during the past four seasons produced much higher yields of potatoes than a series of plats which produced cash crops of cotton or corn during the same period. The presence of coarse organic matter on the corn land caused a marked increase in the amount of scab which developed on the tubers.

Yields of tomatoes from the land that grew summer legumes for four seasons were only slightly higher than those from plats which grew cash crops during the past four summer seasons.

Garden beets produced on land previously planted to Brabham cowpeas showed a lower percentage of nematode infestation, and yields of marketable sized roots were consistently higher on the legume plats.

Tomato Variety Tests: The Lower Valley is an early spring tomato producing area of considerable importance, but the quality of the final market product is not up to standard because no effort has been made to standardize on one or two well adapted varieties. Since the introduction of the Rutgers variety, shippers and growers are more nearly in agreement than at any time since the tomato industry was established. However, Rutgers is not an early variety, and every effort should be made to develop a strain of this excellent variety that will produce a larger percentage of the crop during the period of high market prices. Hybridization with early maturing, open-vined varieties may solve the problem, or entirely new varieties may be developed. Varieties such as Stokesdale, Clark's Early, Bonny Best, Break O'Day, and Grothen's Globe will produce much higher yields of early tomatoes than varieties such as Rutgers, but the first three varieties are not resistant to soil-borne diseases and none of the lot is equal to Rutgers in color and interior quality. One of the most interesting varieties in the test was Double Red Plum, an enormously productive variety even under adverse conditions, and a valuable sort for catsup and juice manufacture because of its high color and fine flavor.

Tomato Fertilizer Tests: Two fertilizer tests were conducted with tomatoes during the spring season of 1938. One series of tests was planted on the station farm on plats of sandy loam soil that had previously received five annual applications of fertilizer concentrates. The other tests were planted on black, clay loam soil near Los Fresnos, Texas, that had not received previous fertilizer treatment.

On the station test plats, highest yields of marketable fruit were produced on the plats receiving 600 pounds per acre of 6-18-0 and 6-18-6 fertilizers. The highest yields of first grade fruit from the Los Fresnos test plats were produced on plats that received sulfate of ammonia at the rate of 100 pounds, 32 per cent Superphosphate 200 pounds and Kainit (potassium-magnesium chloride) 100 pounds per acre.

Papaya Breeding and Improvement: The commercial production of papayas in the Lower Valley region has been hindered to a marked degree by the lack of stabilized varieties that produce uniform fruits of good flavor and desirable shipping quality. During the past season, seeds of twelve families of papayas that have been "purified" by sib pollination, within the families, were received from the U. S. D. A., Subtropical Fruit Research Laboratory at Orlando, Florida. Plants were grown from each of these lots of seed by starting the seedlings in small pots which were plugged into the soil of a nearly spent manure hot-bed. The seeds were planted early in March and the seedlings transplanted late in April, under very adverse conditions. Development of the plants was retarded by the unfavorable weather, but by late summer, many of the plants were setting fruit. Three plants of a "variety" were set in each hill, so that male plants would be available for use in hand pollinating the female flowers. First efforts at pollination were unsuccessful, as the cellophane and

glassine bags used to cover the female flowers caused shedding of the blossoms. From five to 20 sib pollinated fruits of each variety were finally secured and seed of these will be distributed for a more general adaptability test of the improved strains. Fruit maturity has been delayed by the cool, dry fall weather, but it is quite obvious that considerable uniformity has been secured in the twelve strains furnished by the Subtropical Fruit Research Laboratory.

Avocado Propagation: The Rio Grande Delta is not well adapted to the production of avocados, especially those of the Mexican type. It is true that Mexican varieties and seedlings are quite resistant to cold, but it is also true that our imperfectly drained, saline soils are not suitable for salt sensitive types of avocados. Seedlings of certain West Indian varieties appear to thrive in our delta soils, and it now seems desirable to attempt the propagation of some of the excellent cold hardy varieties that have been discovered by the U. S. Subtropical Research Laboratory, on salt resistant understocks. Recent improvements in the technique of grafting avocados makes the commercial exploitation of this nursery enterprise much more practicable than at any time in the past.

Strawberry Production: Mild winter temperatures make it possible for Valley growers to establish strawberry plantations during the fall season and obtain fair yields of berries during the late winter and early spring seasons. Where well grown, strong plants are available within a one-day trucking radius, it should be profitable to expand the strawberry acreage in this region. Early varieties of berry plants developed and grown by the Winter Haven Station were received and planted in early October and were producing ripe berries of merchantable grade by the latter part of December. The use of intensive methods of berry culture, and utilization of the improved varieties now available, should make winter strawberry production a profitable horticultural enterprise for the Valley.

Ornamentals: The collection of ornamental plants was considerably increased during the past year. Among the more important subtropicals which have become well established are: Traveller's Tree, *Ravenala madagascariensis*; Rice Paper Plant, *Tetrapanax papyrifera*; Sausage Tree, *Kigelia pinnata*; Calibash Tree, *Crescentia alata*; Monkey Puzzle, *Araucaria imbricata*; Cucumber Bush, *Averrhoa bilimbi*; Royal Palm, *Oreodoxa regia*; Queen Palm, *Cocos plumosa*; Pigmy Date Palm, *Phoenix Roebeleni*; Coconut Palm, *Cocos nucifera*; Queen Cycad, *Cycas circinalis*; *Zamia floridana*; Star Pine, *Araucaria excelsa*; Sea Grape, *Coccoloba uvifera*; Woman's Tongue, *Albizia lebbek*; Red Flowered Tulip Tree, *Spathodea campanulata*; Banyan Tree, *Ficus benghalensis*; *Thunbergia grandiflora alba*; Mammoth, Double Poinsettia and three new species of Bauhinia; and collections of Crotons and Acalphas.

Of the hardy exotics, Governor's Plum, *Flacourtia indica*; Cajaput, *Melaleuca leucadendron*; Surinum Cherry, (*Eugenia uniflora*) deserve special mention.

Growing Plants Without Soil: Because of the general interest in soil-less plant culture, several sets of experiments were conducted in this field of horticulture. Ten different culture solutions, ten types of containers and eight kinds of supporting media were used in the studies. Of the crops grown, more trouble was experienced with strawberries and gladiolas. Subjects best suited for this method of culture were: crotons, avocados, Ficus, iris, caladiums, celery, tomatoes, and cucumbers. Strawberries were successfully grown in sand cultures, using nail kegs as containers. Seedlings of a number of plants, including celery, were very successfully grown in flats of sterilized sand that were watered with a simple nutrient solution. The use of alkaline river water that also has a rather complex flora and fauna, introduces factors relating to biological and chemical balance which complicates the growing of plants in pure water culture. Straight sand culture, or a combination of sand culture and water culture is much more successful than growing the plants without any root anchorage in solid media.

Experiments with Agronomic Crops

Cotton Variety Test: Of the sixteen varieties grown under test during the 1938 season, Delfos 719, Stoneville 5A, and New Mexico Acala were the most desirable from the standpoint of yielding capacity and quality of lint. Some of the prolific short staple varieties yielded well this season because of severe boll weevil damage during June, but the value of the crop was less than that of the better, long staple varieties.

Cotton Fertilizer Tests: One fertilizer test with cotton was conducted on sorghum stubble that showed outstanding benefits from one type of fertilizer (cyanamid) applied three months prior to planting. An equal money value in complete (4-8-4) fertilizer applied at planting time increased the yield of lint cotton only 39 pounds per acre, while the cyanamid treatment increased the yield of lint cotton from 659 pounds for the untreated plats to 990 pounds.

Catch crop cotton grown on fertilizer test plats used for cabbage during the winter season showed marked benefit from the residual effects of superphosphate applied at the rate of 600 pounds per acre during the past four seasons. Nitrogen alone and in conjunction with superphosphate also gave consistent increases in yield.

Corn Variety Tests: Louisiana grown seed of the standard Tuxpan variety produced the highest yield during 1938, 71.1 bushels per acre, compared with 66.0 bushels per acre for yellow Tuxpan.

Flax Adaptability Tests: Curtailments in the acreage planted to cotton has stimulated interest in other cash crops of a staple nature. The excellent results secured in other irrigated regions with seed flax made it desirable to conduct adaptability tests with two of the more important varieties. Seed of the Rio and Punjab varieties were planted January

5th, and the crop was ready for harvest about May 15th. Yields of cleaned seed were 29.0 and 22.7 bushels, respectively. Because of the apparent adaptability of the crop to Valley conditions, commercial planting has been advocated by the station, and several thousand acres were planted during the fall season of 1938.

Summer Legumes: A planting of *Crotalaria juncea* (Sunn hemp) produced enormous yields of coarse plant material for soil improvement and made good yields of seed. This is one of the few places in the continental United States where *Crotalaria juncea* produces seed. Since the crop, immune to nematodes, is valuable as a soil improving crop and has some value as a fiber plant, its extensive trial in the Valley should be encouraged. Seed will be distributed to cooperators during the 1939 season.

Soy beans will produce good yields of seed when planted during the fall season, provided the crop is protected from rabbits. Many varieties fail to produce seed when planted during the spring season.

There is a good local demand for dry beans, and growers are being encouraged to plant a part of their retired cotton acreage to this crop. Fall plantings of Pinto beans produced very satisfactory yields, even though the 1938 fall season was the driest since 1921. Dusting with sulfur to control leaf hoppers was very beneficial.

Winter Legumes: Of the legumes utilized for soil improvement, Hubam Clover ranked first and yellow Sweet Clover second. Fenugreek failed to yield any more forage than alfalfa, and the hay was not nearly so valuable.

Miscellaneous Agronomic Crops: Wintersome sorghum appears to be a true hybrid between saccharine sorghum and sugar cane and produces gigantic leafy plants with large, sweet stems that resemble sugar cane. The plants are not very resistant to cold, as a temperature of 30 degrees on November 28 caused complete defoliation.

A planting of certified, pure lined Sumac sorghum was made alongside of a comparable field of Red Top sorghum grown from seed of the type commonly offered for sale in the Valley. The superior seed produced a very uniform population of leafy plants that yielded twice as much grain as the coarse, hybrid plants grown from the commercial seed.

A planting of fourteen new strains of Sudan grass was kept under observation during the summer season. Some of these Sudan selections have superior qualities as forage plants, and several of the strains are definitely resistant to destructive leaf and stem diseases.

Seeds of rust resistant strains of barley, oats and wheat, and salt resistant clover were made during the fall season.

W. H. Friend.

Plant Disease Investigations

Plant disease investigations at Substation No. 15 have covered the entire range of crops grown in the Lower Rio Grande Valley, including citrus, cotton, potatoes, winter and spring vegetables, and forage and fiber crops. Since the total volume of such crops grown is rather large as compared with similar areas elsewhere in the State and in the country, the total value of applied information on disease control to the growers as a whole is apt to be of a rather high order.

Citrus gummosis and wood rot.

This serious disease is definitely the cause of the death of hundreds of trees in the Rio Grande Valley every year. In the advanced stages, such as those that are just now at their height (following infections that occurred at the time of the destructive hurricane in 1933), it has not been possible, as yet, to stop this disease by tree surgery methods. For such cases, it is advised to give the tree the best possible care in the way of watering and fertilization as long as it continues to bear a marketable crop. As soon as the foliage turns permanently yellow and the fruit is undersized, the tree may as well be removed.

Protection of young trees against infection.

Progress has been made in the development of disinfectant wound treatments to be applied to pruning and other wounds on young and healthy trees for the purpose of preventing infection. Pruning wounds on healthy wood have always healed satisfactorily (1) if the cuts are properly made, with smooth edges and no projecting stub; and (2) the exposed surfaces are treated with any one of several non-injurious disinfectant pruning-wound paints. Even actively gumming new infections have been stopped abruptly by removing the affected wood and bark, applying a plant-safe disinfectant carbolineum, and covering the wound with a mixture of carbolineum and asphaltum. Many commercial pruning compounds, however, have been found to be worthless or even harmful. The "perfect" compound is still being sought.

Sour orange resistant to gummosis.

Infectious gummosis is definitely stopped in its downward progress in the trunk as soon as it reaches the bud union with the sour orange root stock. This has been shown by longitudinal sections through the trunks of badly infected trees and also by the excavation of discolored infected wood in standing trees.

Inoculation studies.

Success has not yet been attained in procuring a definitely pure culture of the typical gummosis fungus. Diplodia-like cultures have been obtained repeatedly, and inoculations with these produce gumming cankers and darkly discolored wood. But in no case has the actively growing pink-wood producing symptom been reproduced artificially.

Lemon stem end rot.

Stem-end rot caused by *Diplodia natalensis* was particularly severe on both Meyer and Eureka lemons from August to October, 1938. The standard commercial control measures were not satisfactory, for on occasional shipments, as high as 50 per cent losses were reported before the lemons reached the ultimate consumer. The standard hot borax treatment, while greatly reducing decay, caused a shrinking of the fruit during the period of exposure to ethylene gas in the coloring room. Fruits waxed to prevent shrinking before the color treatment, did not color. Many of the commercial soap washes did not give good control.

Stem-end rot control experiments.

During the season, five experiments on a wide range of fruit treatments applied prior to the coloring process were performed, using thousands of fruits. The treatment units consisted mostly of 100 fruits to each treatment. While another season will be required before commercially applicable results can be reported, some leads were obtained, as follows: (1) Spraying of fruits several days before picking with various fungicidal sprays did not materially reduce the development of decay. This conclusion is vitiated to some extent, however, by the occurrence a few days after the treatments, of heavy rains that not only washed off spray residues but also made conditions particularly favorable for decay to occur. (2) Stem-end treatment of fruits immediately after harvest with disinfectant chemicals are indicated as offering the greatest promise of contributing to control. Alcohol treatment alone did not reduce decay. Alcoholic mercury bichloride stem dips at 1 to 500 and 1 to 1,000 concentration invariably reduced decay greatly, sometimes completely eliminating it, as in one case when 20 per cent loss occurred in the controls. Benzoic acid, salicylic acid, and iodine in alcoholic solutions greatly reduced decay, but not as well in any case as did bichloride. In the same experiments, the commercial soap washes, copper sulfate 1 to 500 and 1 to 800 dips, and malachite green 0.1 per cent in water and 0.05 per cent in 50 per cent alcohol as stem dips did not give control. Since alcoholic bichloride stem dip so consistently gave good results, an effective non-poisonous substitute for it is being sought for future experiments.

Citrus chlorosis.

In some soils in the Rio Grande Valley, the high alkalinity of the soil "ties up" in insoluble form some of the mineral elements necessary for healthy tree growth. Very promising results have been obtained from experiments on the use of sulfur as a soil amendment for the control of this disease. Twenty pounds per tree applied in holes brought about in two years an improvement from an average of 50 per cent chlorotic to nearly chlorosis-free. At the same time, it brought about an accrued tree caliper of 1½ inches whereas untreated checks increased only 1.2 inches—a difference of 25 per cent in favor of the sulfur treatment.

In another test, the application to each tree of 20 pounds of sulfuric acid diluted to five per cent in water, did not bring about the same degree of recovery as did sulfur.

The application of various mineral salts as sulfates in various combinations with sulfur appeared to assist to a striking degree in bringing back an orchard that was in very bad chlorotic condition prior to the 1938 growing season. Another year will probably be required before the best combination can be detected by measurable means. Such a combination is indicated as being a means of hastening the recovery of trees with types of chlorosis that are due to some definite mineral deficiency.

The development of a sulfur-organic acid compost.

Sulfur acts, as an acidifying agent for the soil, by virtue of its gradual oxidation into sulfuric acid. One pound of sulfur is the equivalent of three pounds of sulfuric acid in total ultimate acidifying value. Sulfur alone, however, is inert, and some time is required before a sufficient portion of it becomes oxidized to release much acid into the soil. By composting a mixture of about equal parts of sulfur and organic materials in a pit in the soil and allowing the mixture to weather for six months or so, free acidity is developed in the mixture, and the application of such compost in place of pure sulfur will produce an acidifying effect sooner than if sulfur alone is applied. By way of a preliminary experiment along this line, the charred dust from citrus peel dehydration drums was used as the source of organic material. This material had an initial content of lime (as Calcium oxide) of about nine per cent. At the end of eight months, the lime had become completely neutralized of its potential alkalinity, and there was a free acidity in the compost of 1.6 per cent. Since the charred material is at present a waste product from the dehydration plants, it can be procured very cheaply. After composting with sulfur, it becomes a very useful mixture that may be applied to plants of various kinds to aid in overcoming chlorosis.

Potato Diseases

Potato late blight.

The early Cameron County spring crop of potatoes was subjected to the worst outbreak of late blight in several years. In many fields protective measures were not applied until it was too late and losses were severe. In extensive areas, however, copper was applied in the form of sprays and dusts (the dusts in part by airplane), and in some cases striking control was obtained. An extensive spraying and dusting experiment was initiated on February 28, shortly after the first outbreak of the disease. At the end of the season yield records showed that the best of several sprays used was a low lime Bordeaux (5-1½-50) that gave a significant increase of 1,804 pounds of potatoes over the checks. Straight 5-5-50 Bordeaux gave 907 pounds increase. Other increases were: for basic copper sulfate, 5-50, 1,534 pounds per acre; "Cuprocide 54" 1½-50, 1,237

pounds; copper-lime dust 25-75, 1,169 pounds; Copper Hydro-40 10-20 dust, 1,136 pounds; Nichols Z-O fungicide 1½-50 spray, 1,112 pounds; Copper Hydro-40 5-50 spray, 954 pounds. Several other materials gave increases of less than that obtained with standard Bordeaux, but all of them significantly greater than the checks.

Copper spray and dust coverage and adhesiveness.

Using the Blodgett-Mader potassium ferrocyanide paper process, large numbers of tests were made to determine the coverage obtained immediately after application, and adhesiveness following winds and rains, with the various sprays and dusts used. The sprays in general showed good adhesiveness. The dusts, however, did not generally stick well following rains. The use of a spreader-sticker complement to dusts is indicated as being highly desirable.

Tests of coverage obtained by airplane dusters were informative. The applications made by one dusting company appeared to be particularly efficient in getting good under-surface coverage. In this case, a special type of Venturi-tube appeared to deliver the dust in such a way as to drive it downward with considerable force. The result is that the dust strikes the ground and rebounds with a rolling motion, thus reaching lower surfaces that are not ordinarily reached by airplane dusting.

Potato early blight.

Four thorough sprayings with Bordeaux 5-5-50 with a ten-row sprayer at 400 pounds pressure, conducted under the observation of the substation plant pathologist, apparently prevented the occurrence of early blight on a large commercial fall acreage of Bliss Triumph potatoes. In one area that was not sprayed regularly the disease had made its appearance by the latter part of November. Last year this disease caused upwards of 50 per cent loss in the fall crop in the same locality.

Notes on spraying equipment.

Important observations on materials and equipment were made. Commercial "builder's" hydrated lime was used in making the sprays used in the above operations. Under the 400 pounds pressure, a single day's use regularly wore the holes in the nozzle disks from an initial diameter of one millimeter to a full two millimeters, or quadruple the cross-section area. This materially altered the type of spray produced by the end of the day. Likewise the brass spreaders in the nozzles became badly worn, in some cases entirely through in the center, after three or four days of use. It would seem to be advisable to use a finer grade of lime in the sprays, such as the new colloidal hydrated lime or freshly slaked rock lime, in order to avoid this excessive mechanical abrasive action of the lime particles. Since effectiveness of sprays demands the best possible fine mist applications, properly directed, particularly for potato foliage diseases, avoidable errors in the way of poor nozzles should be guarded against.

Vegetable Diseases

Cabbage black rot.

Cabbage black rot has been unusually severe in the Lower Rio Grande Valley in the 1938-39 winter crop. Random surveys have shown losses as high as 75 and 100 per cent by actual count in occasional fields. Most of the disease is directly traceable to infected seed. Washington State, the usual source of supply of relatively disease-free seed, was apparently short this past season, and most of the seed used in the Valley came from Europe. Unfortunately a great deal of planting was done with the important feature of seed treatment neglected.

The Experiment Station plantings were made with seed receiving the standard 30-minute soak in mercury bichloride followed by a quick rinsing in clear water, drying until free from surface moisture, and then immediate planting. Practically 100 per cent field stands were obtained, completely free from primary black rot infection. The mild leaf symptoms that have been seen on a few plants, mostly in fields that had cabbage last year, were traceable in large part to the infection of leaves in contact with the soil, clearly indicating survival of the organism in the soil from the previous year.

Seed treatment experiments for black rot control.

It has appeared from experiences of growers and our own experiences that the half-hour soak in bichloride sometimes reduces the stand rather seriously in the seed bed. Tests conducted with a wide range of other chemicals including organic mercuries, salicylic acid, and benzoic acid have shown excellent germination as compared with the bichloride and with the untreated checks. It remains to be determined what the effects of the new treatments have been on black rot development.

Tomato bacterial soft rot.

Following the report of a 15 per cent penalty on a carload of tomatoes shipped from Brownsville to New York in May, 1938, an investigation was made of conditions related to that particular shipment. It had appeared that fruit from some fields had shown decay while those from other fields had shown none. A field trip disclosed considerable field rot in some fields and little or none in others. Packed boxes from different fields were held for four and seven days for observation. Some boxes showed no decay whatever even after seven days, whereas other boxes showed 35 per cent and 14 per cent rotted in four days, and practically 100 per cent rotted after seven days in one case. A field source, therefore, appeared to be responsible for the initiation of rot. Because of the clear evidence of spread throughout a pack by means of a wet-wax treatment, the use of some disinfectant when such treatment is used may prove to be advisable.

Bean root-rot, *Pratylenchus pratensis*.

In a commercial field of string beans north of the Experiment Station, several large areas died out completely due to heavy infestation of the roots and the stalk bases by the meadow nematode, *Pratylenchus pratensis*. This nematode has previously been observed in the Valley on eggplant. The finding of this nematode as a serious factor on beans is important in that it indicates that this type of failure heretofore attributed to cotton root rot or to unknown causes may in many cases be due to the activities of this nematode. A judicious rotation with an entirely different type of crop is recommended as a control measure.

Corn Stalk Rot

In April, 1938, a corn stalk rot appeared in an experimental planting of field and sweet corns. Plants that had been in a collapsed condition for one or more days had a putrid odor and were swarming with bacteria in the region of decay. Freshly collapsed plants, however, showed the presence of a Phycomycetous fungus, later identified as *Pythium butleri*, in the advancing region of decay, and this fungus was readily isolated from such regions. Repeated inoculations in both field and sweet corn reproduced typical symptoms of the disease in practically all cases, and the same fungus was readily reisolated. Survey trips through farms in the vicinity of the Experiment Station showed that this disease was rather common and that in low-lying, over-irrigated sections of fields, losses of plants up to 50 per cent were noted. Additional symptoms noted during the season were (1) watery soft rot of leaf sheath bases near the ground, followed by shredding of the tissues (such tissues almost invariably contained oospores of *Pythium*); (2) a soft rot of axillary buds and rudimentary ears, with Phycomycetous hyphae and sometimes oospores to be found; (3) reddish lesions in leaf sheaths and corms. The evidence points toward the conclusion that this disease, reported herein for the first time, may be responsible for reductions in stand and yield of corn not accounted for in the past. The symptoms of the disease greatly resemble those described by Dr. H. R. Rosen of Arkansas for a bacterial stalk rot of corn (Ark. Agr. Exp. Sta. Bul. 209. July, 1926). Care to avoid excessive standing water about the stalks of corn at any time during the growing season is advised as a logical control measure.

Cotton Root Rot

The 1938 season, in general, was not so bad for root rot in Rio Grande Valley as it had been the year before. This was no doubt due, in part, to the shortage of rainfall during the summer. Extensive records have shown a striking relationship of incidence of new cases of root rot to periods of rainfall immediately preceding.

In one field of eggplant, about 25 per cent loss resulted from infection of the plants by *Phymatotrichum omnivorum*. The fungus was isolated

readily from the cortical tissues in the crown of the plant. This suggested the use of eggplant as a suitable "indicator plant" for studies on the control of cotton root rot.

The studies on soil acidifying potentialities of sulfur and sulfur-organic composts have paved the way for their inclusion in root rot control experiments involving the acidification of the soil in the plant row.

Soil Sterilization by Chloropicrin Fumigation

The use of chloropicrin for soil sterilization by fumigation under a gas-impervious paper cover was demonstrated several times during the past year. In one case, two 30-foot greenhouse ground level "benches" surrounded by boards were treated by the injection of chloropicrin at the rate of $2\frac{1}{2}$ cc. per square foot of surface and covering with a 4-foot wide strip of glue-lined, gas-proof paper. The resulting growth of such plants as snapdragons and sweet peas has been excellent, whereas the previous plantings of these ornamentals were badly diseased with the root-knot nematode. In another case, soils that had formerly developed severe cases of damping-off when used for cabbage seedbeds were sterilized in closed containers. The result has been perfect stands of cabbage seedlings without any collapse of plants whatever.

Miscellaneous Plant Diseases

Aside from the major plant diseases herein reported, some 80 other diseases, on 30 different host plants received attention during the year. Most of these were brought in for identification and control recommendations. These are included in the list of plant diseases encountered in the Rio Grande Valley, submitted for the National Plant Disease Survey.

C. H. Godfrey.

Horticultural Investigations

Experiments with Citrus Fruits

Citrus Crosses: A large number of crosses between different varieties and kinds of citrus were made. The following crosses were successful: Hamlin orange crossed with Chamoudi orange, and Valencia orange crossed with Hamlin orange. The latter cross, however, proved to be seedless. Seedlings growing from crosses of previous seasons are: Thornton tangelo-Ruby grapefruit cross, Thornton tangelo-Valencia orange cross, Thornton tangelo selfed, Texas Navel orange-Meyer lemon cross, Valencia orange-Meyer lemon cross, Temple orange selfed, Ruby orange-Meyer lemon cross, Thornton tangelo-Clementine tangerine cross, Thornton tangelo-Pink Marsh grapefruit cross, Pineapple orange-Pink Marsh grapefruit cross, and Valencia orange selfed. None of these seedlings are of bearing age.

Citrus Orchard Heating: The size of the area in the orchard heating test at Engelman Gardens is approximately 450 acres. The heaters were placed in the orchard and filled with oil ready for firing. Thirty-six thermometer stands were erected in advantageous locations throughout the orchards. Heaters were placed in orchards containing grapefruit, oranges, and lemons.

Weather conditions did not necessitate firing the heaters; hence the test was not conducted this season.

Citrus Wood Decay Investigations: This project was initiated during the fall of 1937 in cooperation with the Division of Plant Pathology and Physiology. Forty-eight treatments were used on the bark and cut surfaces of citrus branches. There is a definite need for a water repellent antiseptic wound dressing which is non-injurious to citrus. Although no definite conclusions or recommendations are justified at this time, one substance tested, a petroleum resin varnish, appears to be an ideal vehicle for antiseptic materials.

Citrus Variety Descriptions: Detailed physical measurements, such as diameter and depth of fruit, stem and blossom-end shape, rind thickness, number of segments, regularity of segments, number of seeds, and volume of juice, were made on two varieties of lemons, the Perrine and the Meyer. The same type of data have been obtained on Hamlin, Parson Brown, Pineapple, Ruby, Joppa, Homossasa, Temple, Valencia, Washington Navel, Texas Navel, and Bahia Navel oranges; on Marsh Seedless, Little River Seedless, Thompson, Thompson Blush, Duncan, McCarty, and Foster grapefruit; and on the Dancy, Clementine, and Willow Leaf tangerine, and the Owari satsuma.

Experiments with Vegetable Crops

Tomato Crosses: Several inter-varietal crosses were made; the following were successful: Master Marglobe crossed with San Marzano, Master Marglobe crossed with Scarlet Dawn, Master Marglobe crossed with Break O'Day, and Rutgers crossed with Stokesdale. Seed were saved from the F₄ generation plantings of crossed tomatoes. Individual plant selections were not made, but care was exercised to avoid saving seed from off-type plants. The following crosses are the ones selected for further testing: Coopers Special X Marglobe, Coopers Special X June Pink, Marglobe X Pritchard, and two strains of Bonny Best X Coopers Special.

Adaptability of Vegetable Varieties for Canning and Quick-freezing: This is a cooperative project with the U. S. Department of Agriculture, Citrus Products Laboratory. In the spring of 1938, twenty varieties of sweet corn and eight varieties of lima beans were grown. In the fall of 1938, twelve varieties of English peas and eight varieties of snap beans were grown. No notes were obtained on the fall plantings, due to poor growing conditions and an early frost which destroyed the plants.

Sweet Corn Varieties for Canning and Quick-freezing: Of the twenty varieties of sweet corn grown, nine varieties were yellow and eleven were white. The highest yield from the white varieties was 6,236 pounds of freezable ears per acre from Georgia No. 496. Surecropper Sugar was second in yield with 3,576 pounds. From the standpoint of quality, Iogent 1612 X 1445 was outstanding for the white varieties. The acre yield on this variety was 2,433 pounds. Of the yellow varieties, Iogold P 13 X I 45 was the highest yielding, with 1,646 pounds per acre of freezable ears.

Bean Varieties for Canning and Quick-freezing: The highest yielding variety of lima beans was Henderson Bush, with 2,228 pounds per acre of shelled beans. The next highest yielding variety was Baby Potato lima, with 1,409 pounds of shelled beans per acre. For use in quick-freezing, the size, color, and quality of these two varieties was outstanding.

Cooperative Vegetable Trials in Cameron County

Cabbage Variety Tests: A series of experiments was begun in Cameron County during the fall of 1938. These tests will be conducted on clay and clay loam soils not found on the station grounds. The fall planting for 1938 consisted of a variety test and a fertilizer test on cabbage. Twenty varieties of cabbage were planted in quadruplicate. Each plat consisted of one one-hundredth acres.

Cabbage Fertilizer Tests: The fertilizer plats were planted to the Glory of Enkhuisen variety. Seven fertilizer treatments were applied and the test was run in quadruplicate.

Experiments with Date Palms

(In cooperation with Bureau of Plant Industry,
U. S. Department of Agriculture)

Variety Adaptability Studies: There are 196 established palms of 25 varieties on the station. Of this number, 76 are from Iraq, two from Arizona, and the remainder from California.

The following varieties are represented in the station collection: Maktoom, Halawy, Thoory, Zahidi, Saidy, Safrania, Dubaini, Hayany, Deglet Noor, Tazizoot, Okht Fteemy, Khadrawy, Sukkar Nabat, Kustawy, Tadala, Amir Haj, Khatuni, Jaffary, Bedraya, Khasab, Sayer, Ashrasi, Bahrab, Dayri, and Braim.

Propagation and Fruiting of Date Palms: Fifteen offshoots were removed and set in the permanent garden on the station. Twenty offshoots were given to cooperators for testing, eight of which were set in the Lower Rio Grande Valley, and twelve in the Laredo area.

One hundred and thirty fruit bunches were borne on 47 palms of the following 16 varieties in 1938: Halawy, Thoory, Zahidi, Dubaini, Amir

Haj, Tazizoot, Khadrawy (Cal.), Bedraya (B), Deglet Noor, Tadala, Khadrawy (Iraq), Khasab, Ashrasi, Dayri, Bedraya (M), and Sayer. The ripening of the fruit on the palms was generally unsatisfactory. One variety, however, namely Khadrawy (Cal.), ripened perfectly despite unfavorable weather conditions.

Miscellaneous Tests

Strawberry Adaptability Test: An adaptability test of eight varieties of strawberries, developed at the Winter Haven Station, was started in the fall of 1937. Carolina Missionary and Klondike were used as checks. Ripe berries were obtained in December, but the peak harvest occurred in February and March. Klondike gave the highest yield for the season, with Texas No. 21 second, and Texas No. 15 third. The only other Texas variety with a fairly high yield was No. 54.

J. F. Wood.

Citrus Insect Investigations

Population Studies with Rust Mites: Rust mite population counts were made at different intervals throughout the year on an untreated row of grapefruit trees. A one-half inch square "Linen Testing Lens" used to observe the mite infestation has proven to be better than the leaf washing method because it is much faster. When four or more mites were observed within the one-half inch square on thirty per cent of the leaves in the sample, it was deemed advisable to recommend control measures.

Rust mites were present throughout the year. The largest numbers occurred during the latter part of March and the first week of April. Almost as many occurred during the first half of September as occurred during March and April. Unusual weather conditions such as dust storms, windstorms, northers, and excessive temperatures cause a reduction in numbers of rust mites, whereas, cool moist rainy weather promotes rapid increases of rust mites. More mites were observed on the under sides of the leaves than on the upper sides of the leaves, in practically all cases.

Control of Scale Insects: Comparisons were made of three different grades of oil emulsions in which oil soluble emulsifiers were used and two different brands of tank mix. One of these oil emulsions contained creosol in sufficient quantities to irritate the skin of the persons who applied it. Some of the poor results obtained with one of these oils may be attributed to the action of creosol on the entomogenous fungi and its repellant action on parasites and predators. The tank mix spray gave slightly better scale control than the oil emulsions. Application of all materials was made with a power sprayer at 400 pounds pressure during the period from July 1 to July 10. Reinfestation occurred rapidly on all plats during September and October, probably because of the extremely dry weather that checked activity of entomogenous fungi and increased the dust factor that appears to be closely associated with the establishment of scale crawlers.

Truck Crop Insect Investigations

Control of worms on Broccoli: The pyrethrum (.075 per cent pyrethrins)-cube (.5 per cent rotenone)-sulfur mixture gave the best control, and the cube (.5 per cent rotenone)-sulfur mixture was second. Both materials gave a decidedly better control than the calcium arsenate and the arsenate of lead-Talc mixture. Poor kills of worms, by the materials in each case, indicates that it is necessary to make the application at regular intervals.

Control of Tomato Fruit Worms on Tomatoes: Calcium arsenate was slightly better than both calcium arsenate-sulfur (50-50) and calcium arsenate-lime (50-50) for control of the tomato fruit worm on tomatoes; however, kills above 95 per cent were obtained with all three materials tested.

Preliminary Tests in the Control of Garden Fleahoppers on Tomatoes: One application of three different sets of materials, including sprays and dusts containing nicotine, pyrethrum, and rotenone mixtures, was made during May for the control of garden fleahoppers (*Halticus citri*, Ashmead) on tomatoes. No satisfactory kill was obtained with the materials used in any case, but some repellent action on the hoppers was noted with all materials tested.

Control of Beet Webworms on Beets: Cube-penetrol spray gave slightly better control of webworms on beets than pyrethrum-cube-sulfur dust and calcium arsenate dust. These materials were decidedly better than pyrethrum-sulfur dust and arsenate of lead spray.

Control of Bean Leafhoppers on Beans: Two applications of two different strengths of pyrethrum sulfur mixtures were made at ten-day intervals on beans for the control of the bean leafhopper. Slightly better control was obtained with pyrethrum-sulfur containing .7 per cent pyrethrins than with pyrethrum-sulfur containing .05 per cent pyrethrins.

Control of Eggplant "Yellows": Excellent control of "Yellows" of eggplants was obtained by dusting with sulfur twice in the seedbed and at 15-day intervals after transplanting to the field.

Miscellaneous Tests

Control of Thrips on Cotton: One application of approximately 20 pounds per acre of three different materials was made during April for the control of thrips on young cotton. Best control was secured with pyrethrum-sulfur (20-80); however, the kill of thrips (39 per cent) obtained was not sufficient to be economically practicable.

Control of Harvester Ants: A new method of using carbon bisulfide for controlling harvester ants has been worked out that appears to be very satisfactory. This method consists of pouring about three or four

ounces of carbon bisulfide in a shallow container, placing it in close proximity to the main entrance of the ant hill, and covering the entrance and container with an air-tight cover such as a bucket or tub. Fourteen ant hills were treated with this method during August, and no reoccurrence of ant activity appeared in any of the nests.

T. B. Randolph.

SUBSTATION NO. 16, IOWA PARK

Substation No. 16 is located in the Wichita Irrigated Valley, 2½ miles southeast of Iowa Park, and 10 miles west of Wichita Falls in Wichita County. The latitude is 33 degrees and 55 minutes north; longitude 98 degrees and 39 minutes west; elevation 974 feet above sea level.

The average annual rainfall at this substation is 30.69 inches for the 13-year period, 1926 to 1938, inclusive.

The station comprises approximately 161 acres, of which 90 acres are devoted to crops under irrigation and 71 acres are in river bottom and creek bottom pastures and waste lands. The soil types on the station are of the Miller and Yahola series and are fairly typical of the soils in the irrigated Wichita Valley. The station was established in the fall of 1924 for the purpose of conducting agricultural research and experimental work with all crops grown in the Wichita Valley Irrigation Project. Irrigation water is furnished the station from Lake Kemp and Lake Diversion, through canals of the Wichita County Water Improvement District No. 2. A free and perpetual water right was given the station by the irrigation district at the time the station was established. The work at this station is directly concerned with the general improvement of agricultural crops and farming conditions in the Valley, and particularly stresses such phases of the work as vegetable growing, fruit production, alfalfa, cotton, small grains, and grain sorghum production, crop rotations, the study of the proper uses and amounts of irrigation water, and studies of root-rot diseases of cotton and alfalfa. Studies are also made of other plant diseases as well as insects and their control. Breeding and feeding of sheep is also being given attention.

Cotton

Variety Test: Of 20 varieties of cotton included in the test this year the 10 highest ranking in yield of lint per acre were Half and Half with 559 pounds; D. & P. L. 11A, 523 pounds; Ferguson 406, 519 pounds; Qualla, 485 pounds; Delfos 531B, 478 pounds; Bryant Mebane, 474 pounds; Kasch, Ed., 471 pounds; Shafter Acala, 464 pounds; Stoneville 5A, 463 pounds; and Sunshine, 460 pounds. The lowest ranking of all varieties was Wilds Semi-Wilt Resistant Strain 2 with only 330 pounds of lint per acre.

In earliness, Acala N28-5 ranked first with 55 per cent of the crop harvested in 115 days from planting date, followed by Shafter Acala with

54 per cent in the same period. Stoneville 5A ranked third with 51 per cent in 115 days and Mebane 141 was fourth with 48 per cent. The latest-maturing varieties were Hurley Special and Kasch (Ed.) with 28 per cent and 29 per cent respectively in 115 days.

In lint percentage, Half and Half ranked highest with 43.6 per cent. The next in order were Bryant Mebane with 41.2 per cent; Kasch (Ed.) with 40.8 per cent, and Qualla with 39.8 per cent. Wilds Semi-Wilt Resistant Strain 2 ranked lowest of all varieties, with only 29.5 per cent lint.

In length of lint, Wilds Semi-Wilt Resistant Strain 2 ranked first with staple length of $1\frac{1}{8}$ inches. Delfos 531B ranked second with a staple length of $1\frac{3}{32}$ inches. D. & P. L. 11A, Roger's Acala, and Shafter Acala each showed a staple length of $1\frac{1}{16}$ inches. Varieties producing staple of one inch to $1\frac{1}{32}$ were Jennings, Mebane, A. D., and Bryant Mebane. Varieties producing staple of $15/16$ and $31/32$ were Ferguson 406, Hurley Special, Stoneville 5A, Kasch (Ed.), Mebane 141, New Boykin, Sunshine, Watson, Lonestar, and Qualla. Half and Half produced a staple length of only $13/16$ -inch.

In comparable yields for those varieties that have been included in the test for four or more years Half and Half ranks first with an average of 418 pounds of lint per acre. Ferguson 406 ranked second with 395 pounds, followed by Delfos No. 2 with 386 pounds. Other leading varieties and their yields were D. & P. L. 10, 380 pounds; Qualla, 379 pounds; Acala (Watson), 377 pounds; Watson, 376 pounds; New Boykin, 369 pounds; Stoneville 3, 353 pounds; and Mebane 141, 352 pounds.

Spacing Cotton: Mebane No. 141 was the variety used in the spacing test and the spacings were 3, 6, 9, 12, 18, 24, 30, 36, and 42 inches. This year the 3-inch spacing ranked first in yield with 444 pounds of lint per acre followed by the 9-inch spacing with 441 pounds per acre. The 18-inch spacing ranked third with 436 pounds per acre followed by the 6-inch spacing with 412 pounds per acre. The lowest yield was made by the 42-inch spacing with only 293 pounds of lint per acre.

For the seven-year period 1932 to 1938, the 6-inch spacing ranks first in yield of lint with an average of 397 pounds per acre. The 9-inch spacing and the 12-inch spacing rank second with 394 pounds each, while the 3-inch spacing ranks third with 392 pounds of lint per acre. The 18-inch spacing has averaged 376 pounds of lint per acre while the 30-inch and 36-inch spacings have averaged 339 and 335 pounds respectively. This narrow range in yields indicates that a very wide variation in stands of cotton can occur without greatly affecting yields under irrigation.

Dates of Planting: Mebane 141 was the variety used in this test. Plantings were made on April 18, May 3, May 14, June 1, June 15, July 2, and July 18. The highest yield this year was made by the April 18 planting with an average of 400 pounds of lint per acre. The next high-

est yield was 331 pounds from the May 14 planting, followed closely by a yield of 330 pounds from the June 1 planting. The July 2 planting yielded only 14 pounds of lint and the July 18 planting failed to mature any cotton.

For the eight-year period, 1931-1938, cotton planted between the dates of May 31 and June 3 ranked first in yield of lint with an average of 324 pounds per acre. The earliest plantings, between April 18 and 28, ranked second with an average of 286 pounds, while plantings made between May 14 to 21 ranked third with an average of 268 pounds per acre. The average for the June 15 to 20 plantings was 202 pounds of lint per acre while the later dates dropped to insignificant yields. It is evident that a normal cotton crop can be obtained from plantings made between April 18 and June 1.

Amount of Irrigation Water for Cotton: The object of this test is to determine the optimum amount of water to produce a normal crop of cotton. Both rainfall and supplemental irrigation water are considered from the time of pre-planting irrigation to the beginning of the harvest period. Mebane 141 was the variety used in this test. No pre-irrigation was needed this year due to excessive rainfall which delayed planting until near the middle of June. There was a total of 12.44 inches of rain between the first of May and the 15th of June which provided a maximum amount of soil moisture and perhaps had a lot to do with the outcome of yields this year.

Plats receiving a total of 23.44 inches of rainfall and irrigation water yielded 335 pounds of lint per acre while plats receiving 14.44 of rainfall only, yielded 323 pounds of lint per acre. This gives a difference of only 12 pounds between the plats receiving the greatest amount of irrigation water and the plats receiving no irrigation water. Plats receiving a total of 20.44 inches of water yielded 302 pounds of lint while the lowest yield of 245 pounds was made by plats receiving a total of 18.44 inches of water. The similarity of yields between plats receiving no irrigation and those receiving the greatest amounts of irrigation water was no doubt influenced by excessive rains early in the season, lateness of planting, and earliness of maturity.

For the seven-year period, 1932-1938, plats which received an average of 31.04 inches of water ranked first with an average of 343 pounds of lint per acre, while plats which received a total of 28.47 inches of water ranked second with 340 pounds of lint per acre. Yields under other rates of water declined as the amount of water was reduced, with the plats receiving rainfall water only, to the amount of 14.01 inches, making the lowest yield of only 187 pounds of lint per acre.

Grain Sorghum

Variety Test: Of 12 varieties of grain sorghum grown in this test this year, Kalo made the highest yield with an average of 67.8 bushels

of threshed grain per acre. Blight Resistant Milo ranked second with 66.0 bushels and Ajax ranked third with 62.5 bushels per acre. The lowest yield of grain for any variety of grain sorghum was 41.7 bushels for Texas Blackhul Kafir. Golden June corn, included in the test for comparison, made an average of 18.6 bushels of shelled corn per acre.

For varieties that have been included in the test for five years or more, Kalo ranks first with an average of 39.7 bushels per acre. Hegari X Chiltex F.C.16171-1-2-4-3-3 ranks second with 37.1 bushels and Club Kafir ranks third with 36.9 bushels per acre. Texas Blackhul Kafir trails the list with 24.6 bushels. June Corn has an average for this period of only 9.9 bushels per acre.

Variety and Spacing Test: Dwarf Feterita, Hegari, and Texas Blackhul Kafir were the three varieties of grain sorghum included in this test, and these varieties were spaced 3, 6, 12, 18, and 24 inches. In yields, Hegari spaced six inches ranked first with 44.4 bushels of threshed grain per acre, followed by Hegari spaced 12 inches with 41.3 bushels per acre. Hegari spaced three inches ranked third with 40.9 bushels per acre, followed by Hegari spaced 18 inches with 36.6 bushels per acre. Texas Blackhul Kafir ranked fifth with 36.3 bushels per acre, followed by Texas Blackhul spaced six inches with 35.9 bushels per acre. Dwarf Feterita spaced 24 inches made the lowest yield of 22.9 bushels per acre.

For the six-year period, 1933-1938, Hegari spaced three inches ranked first with a yield of 34.8 bushels of threshed grain per acre, and Hegari spaced six inches ranked second with 33.7 bushels per acre. Feterita spaced 12 inches ranked third with 33.1 bushels per acre and Feterita spaced 18 inches ranked fourth with 32.3 bushels per acre. Texas Blackhul Kafir spaced 24 inches made the lowest yield of 21.4 bushels per acre.

Amounts of Irrigation Water for Grain Sorghum: The object of this test is to determine the proper amount of irrigation water and the total water requirements for grain sorghum in the Wichita Irrigated Valley necessary to produce a normal crop. The total natural rainfall from date of pre-irrigation, or such time as pre-irrigation would be applied if necessary, to the date of maturity of the crop is added to the amount of irrigation water applied, measured in acre inches. Spur Feterita was the variety used in this test.

Rainfall was excessive prior to planting this season. No pre-irrigation was necessary, in fact, it was June 10 before the fields were dry enough to plant. The total rainfall from June 1 to September 16 was 14.43 inches. There had been excessive rainfall prior to June 1. Due to excessive rainfall, there was little or no benefit from irrigation water this season.

The no-irrigation check plat made the highest yield of 61.4 bushels of threshed grain per acre. Plats receiving seven inches of irrigation water

in addition to the natural rainfall ranked second with 53.3 bushels per acre while plats receiving the largest amount of water, 12 inches of irrigation in addition to rainfall, ranked third with 52.8 bushels per acre. Plats receiving 10 inches of irrigation water in addition to the rainfall made the lowest yield of 44.4 bushels per acre.

For the seven-year period, 1932-1938, plats which received the greatest amount of water, 36.49 inches, have the highest average yield of 42.6 bushels of threshed grain per acre. Plats which received a total of 33.34 inches of water ranked second with 40.4 bushels per acre, while plats which received 30.48 inches of water ranked third with 39.3 bushels per acre. The lowest yield was made by plats which have received an average of 17.63 inches of water, rainfall plus pre-irrigation only, with an average of only 22.7 bushels per acre.

Small Grain

Wheat Variety Test: Five varieties were included in this test. Yields were far below normal for this station. Denton ranked first with only 9.4 bushels per acre, followed by Tenmarq with 8.2 bushels per acre. Other yields were Quivera with 8.0 bushels, Kanred with 7.2 bushels and Clarks Blackhul with 7.0 bushels. For the five-year average, 1934 to 1938, Quivera ranked first with an average of 26.1 bushels per acre, followed by Tenmarq with 24.3 bushels. Kanred had an average of 23.6 bushels per acre, Denton 23.5 bushels per acre, and Clarks Blackhul 22.2 bushels per acre.

Oat Varieties: Five varieties of oats were included in the test this year. As in the case of wheat, yields were very low for this station. New Nortex ranked first with 38.2 bushels per acre, followed by Texas Red Rust Proof with 35.6 bushels. Nortex ranked third with 34.4 bushels while Frazier made the lowest yield of 29.2 bushels. Of three varieties that have been carried as many as seven years, Texas Red Rust Proof has an average yield of 53.7 bushels per acre, Nortex 51.5 bushels per acre, and Frazier 41.4 bushels per acre.

Barley Varieties: Five varieties were included in this test this year. Yields were far below normal. Bailey ranked first with only 16.8 bushels per acre. Smith 5-3162 ranked second with 15.2 and Finley ranked third with 15.1 bushels per acre. Tennessee Winter 18561 averaged 13.7 bushels and Tennessee Winter 15826 averaged 12.7 bushels per acre. Of three varieties that have been in the test for as many as four consecutive years, Finley ranked first with an average yield of 26.4 bushels per acre while Tennessee Winter 15826 and Tennessee Winter 18561 averaged 23.6 and 23.2 bushels respectively. This period and average includes one year in which the crop was a total loss due to winterkilling.

Crop Rotation Studies

This project consists of studies with eleven combinations of rotations comprising continuous cropping, two-year rotations, three-year rotations, and four-year rotations involving field crops of cotton, small grain, grain sorghums and alfalfa.

For the current season, cotton in rotation No. 11, a three-year rotation of cotton, oats, and alfalfa, ranked first with a yield of 307 pounds of lint per acre, followed by continuous cotton with a yield of 302 pounds per acre. Rotation No. 6, a two-year rotation of grain sorghum and cotton, ranked third with 282 pounds of lint per acre, while rotation No. 9, a four-year rotation of alfalfa, grain sorghum and cotton, ranked fourth with 274 pounds of lint per acre. Rotation No. 10, a three-year rotation of oats, grain sorghum and cotton, made the lowest yield of 236 pounds of lint per acre. Over a seven-year period, continuous cotton has the highest yield rating of 392 pounds of lint per acre, which is 65 pounds above the next highest yield.

Grain sorghum in rotation No. 9, a four-year rotation of alfalfa, grain sorghum, and cotton, made the highest yield of 51.8 bushels of threshed grain per acre. This same rotation has the highest average for the seven-year period, 1932-1938. The second highest yield was 38.6 bushels from rotation No. 10, a three-year rotation of oats, grain sorghum and cotton. This rotation ranks third in production of grain sorghum over the seven-year period, 1932-1938. The third highest yield was 36.5 bushels from rotation No. 8, a two-year rotation of grain sorghum and cotton. The lowest yield was 23.6 bushels from continuous grain sorghum, which also has the lowest rating for the seven-year period, 1932-38.

The highest yield of oats was 40.4 bushels from continuous oat plats, which also have the highest rating in oat production for the seven-year period. The second highest yield of oats was 30.2 bushels from rotation No. 11, a three-year rotation of oats, alfalfa and cotton, which also has the second highest rating for the seven-year period, 1932-38. The lowest yield of oats was 24.5 bushels from rotation No. 10, a three-year rotation of oats, grain sorghum, and cotton. This rotation also has the lowest rating in oat production for the seven-year period, 1932-1938.

Alfalfa in all plats made very low yields this season due to thin stands. The average for all plats was slightly over one ton and for the seven-year period, approximately three tons, there being little difference in yields from the various rotations.

L. E. Brooks.

Fruit Adaptability Studies

Peaches: The great variations in temperature are always a limiting factor in peach production in this valley. Some varieties are more able to withstand the weather conditions than others.

An excellent crop of peaches was set in the spring of 1938, but a hard freeze April 7, 8, and 9, when the fruit was as large as small plums, destroyed most of the crop. Of the 36 varieties of peaches at bearing age only six bore fruit this year, and these sparingly. Dr. Burton, Carman and Early Wheeler appear to be best adapted to the region.

Plums: Plum varieties have a wide variation in blooming dates, so wide that frequently those blooming first are through before the ones blooming last have begun. In general the late blooming plums are the most productive.

While nearly all varieties of plums set a good crop of fruit the April freeze destroyed all of the fruit except that on Opata, Sapa and Munson, which produced small crops. The best adapted varieties seem to be Opata and Sapa, with Waneta, Munson and America producing good crops but not bearing as consistently as the first two varieties.

Apricots: No variety of apricot produced a crop of fruit this year. Moorpark is best adapted to our conditions.

Nectarines: No variety of nectarine fruited this year.

Grapes and Berries: The first condition for success with grapes in this valley is ability to withstand root rot, and the second, a late blooming habit. Of the 20 varieties originally set out in 1931, only Champanel survives 100 per cent. Other varieties showing some resistance to root-rot are Lukfata, Ladano, and Lomato. There were no grapes this year because of the April freeze.

Blackberries and dewberries have not done well on the station soils. Of the six varieties on trial the Youngberry and the Austin dewberry have done best.

Vegetables

Adaptability Studies: The vegetable variety trials included 47 strains representing seven different vegetables.

Of the six English pea varieties on test American Wonder, Gradus, Bliss Everbearing and Dwarf Grey Sugar showed most promise.

Dwarf Horticultural proved to be the most productive of the several bunch bean varieties on trial, with Pinto, a less desirable variety, second, Bountiful third, and Burpee's Stringless Green Pod fourth.

In the cantaloupe trials Hale's Best and Perfecto seem best adapted to commercial production. Two new strains of Hale's Best, 936 and Seed Breeder's show considerable promise.

Black Diamond, Straight 8 and Earliest of All cucumbers seem well adapted to the valley, with Always Green and Early Frame showing promise as high yielding varieties.

Irish Cobbler has proved, over a period of years, better adapted to the region than Triumph. Yields are not large, and it is evident that Irish potatoes are not well adapted.

Of the three varieties of okra in the trials Dwarf Stalked was most prolific with Early Green Pod second. The most desirable variety for culinary purposes, White Velvet, proved the poorest producer.

Of the 10 strains of summer squash the most desirable variety was Early White Bush Scallop.

Fall Trials: Turnips, radishes, kohl-rabi, spinach, mustard and beets have continued to show excellent adaptability. Fall plantings of summer squash, cucumbers, and beans were not successful.

Onion Seed Production: The prospects of a fine crop of onion seed were ruined by a severe hailstorm June 4 which practically destroyed the crop. It is estimated that the storm reduced the yield at least 75 per cent of the average annual production of onion seed.

Asparagus Fertilizer Test: This test included the following treatments: (1) barnyard manure, 20 tons per acre applied in the dormant season; (2) 4-8-4, 400 pounds per acre applied just after the cutting season; (3) the same as (2), plus 200 pounds of ammonium sulfate applied just as growth starts in the spring; and (4) a no treatment check. Seven years' results with these treatments show that barnyard manure has made an average of 639 pounds of tips more per year per acre than the no treatment check, which yielded an average of 1,485 pounds of tips.

Shade Trees and Ornamentals

Trees native to this section of the State are proving most dependable for shade trees. These include pecan, hackberry, western soapberry, mesquite, cottonwood and sycamore. The cottonwood is short lived but it grows rapidly and gives shade in just a few years. Hackberry and western soapberry are hardy but slow growing. Mesquite is slow growing, gives a poor shade, and yet, because of its form, deserves a place in the landscape plan. The Russian mulberry is used to advantage. Although susceptible to root rot it is apparently able to live in spite of it. *Chilopsis linearis* the Flowering Willow is both hardy and attractive as a specimen plant.

Coniferous evergreens that have proved adaptable to local conditions are: Red cedar, Pfitzer's juniper, Arizona cypress, and many arbovitae. A number of broad leaved evergreens such as the ligustrums, pyracanthas, jasmines, and nandinas are showing desirable qualities as specimen, group and foundation planting materials.

A few deciduous shrubs are doing very well, in particular *Vitex agnus castus* and the common salt cedar. *Vitex* is especially good in locations where the soil is poor, both for foundations plantings and screens. Salt

cedar makes a good hedge and screen plant. The native coral berry is hardy and suitable for group or foundation plantings.

Considerable attention has been given to the use of native plants as ornamentals. The following are being used successfully at present: Shades trees, *Sapindus Drummondii*, *Celtis helleri* (Small) and *Prosopis juliaflora grandulosa*; shrubs, *Amphora fruticosa*, *Condalia obtusifolia*, *Bacharis angustifolia*, and *Symphoricarpos vulgaris*; perennials, *Liatris punctata*, *Tradescantia virginiana*; and annuals, *Gaillardia pulchella*, *Corydalis montana* and *Lindheimera Texana*.

B. S. Pickett.

Root Rot Studies

Crude Oil Treatment on Cotton Land: This test included five rates of application of crude oil to land known to be severely infested with the root rot fungus. The test was arranged on a Latin square with six replications. The oil was natural crude from a well in the local Kamay oil field. Application was made in January prior to planting of the cotton in June. Emergence was good and all plats were thinned to uniform stands.

The treatments were (1) 705 gallons of oil per acre, (2) 1,410 gallons of oil per acre, (3) 4,231 gallons of oil per acre, (4) 7,052 gallons of oil per acre, (5) 9,873 gallons of oil per acre, and, (6) no-treatment check.

A final check on the number of living and dead plants at the end of the growing season revealed the following percentages of dead plants due to root rot: treatment (1) 74 per cent, treatment (2) 70 per cent, treatment (3) 58 per cent, treatment (4) 32 per cent, treatment (5) 45 per cent, and treatment (6) 51 per cent.

The average yields of lint cotton per acre from the various treatments were: treatment (1) 342 pounds, treatment (2) 279 pounds, treatment (3) 268 pounds, treatment (4) 241 pounds, treatment (5) 195 pounds, and treatment (6) 349 pounds.

Grape Resistance Studies: Various grape root stocks which have shown marked resistance to root rot in other localities have been tested over a period of years beginning in 1934. Included in these trials were: Champanel, Lomanto, Lukfata, Black Spanish, Dogridge, La Pryor, Mustang, Cloeta, Candicans, Ladano, *Vitis champani*, *V. cinera*, and *V. rupestris*. Results thus far have shown that these stocks are not entirely immune from root rot, but that most of them are decidedly more tolerant of the disease than the grape stocks commonly used.

L. E. Brooks.

Lamb Feeding Experiment

Feeds can be grown abundantly in the Wichita Irrigated Valley. The feeding of livestock has tremendous possibilities. An experiment designed to demonstrate the utility of local grown feeds to make comparisons

between various feeds, and to determine the possibilities of marketing feeds on the hoof, was begun at this station in October. The experiment includes 119 lambs divided into four lots. Comparisons are being made between ground quadron heads and chopped heads, and between alfalfa hay and sudan hay with limestone supplement. The feeding period will not be concluded until in January of 1939.

J. M. Jones, J. H. Jones, L. E. Brooks.

SUBSTATION 19, WINTER HAVEN

Substation 19 is located in Dimmit County, between Carrizo Springs and Crystal City, in the center of a large area specializing in the production of vegetables with irrigation. The substation is located on fine sandy loam (mostly Webb and Crystal series) with about 100 acres in cultivation. Irrigation water is supplied by pumping from underground waters.

The average rainfall for 8 years is 20 inches, but the total for 1938 was only 11.5 inches. The latter half of the year was unusually dry and irrigation requirements were unusually high. This greatly increased the expense of crop production. The earliest killing frost on record occurred on November 8, and ended our fall crops before yield records could be completed. Unusually high temperatures in the latter part of May adversely affected yields of spring crops. Good crops of strawberries, grapes, dates and citrus were secured.

The program includes studies of vegetables, fruits, and other plant crops under irrigation. Disease studies with the principal crops are also being made. Insect work is reported under the Division of Entomology.

Fruits

Adaptability: A severe windstorm on April 7 and 8 blew off many of the newly set fruits and scarred many of those remaining. However, a reasonably good crop was secured from plums, grapes, and citrus.

Apples set a better crop than in 1937, with best yields from Helm, Texas Red, and San Jacinto. Apricots yielded poorly. Guavas and figs bore a good crop.

Eleven of 42 peach varieties failed to set. Best yields were from Babcock, Saucer, Luken's Honey, Waldo, Smith, Pallas, Japan Dwarf, I-16, Shalil and PI-61302.

Good yields of fruit were obtained from Wilders Early, Douglas and Pineapple pears.

In the plum orchard good yields were obtained from Methley, Bruce, Best's Hybrid, Munson, Gonzales, and Excelsior.

De Antequera quince had a good crop as usual.

Citrus Varieties: Generally good yields were obtained from all satsuma varieties although a definite tendency toward biennial crops was observed. Trees with heavy crops in 1937 had light crops in 1938. The earliest to ripen was Morita Wase which began coloring on October 5. The best commercial variety this season was Owari.

All orange varieties gave good yields this year although there was a large per cent of wind scarred fruit. Washington Navel ripened about ten days earlier than Texas Navel and was larger in size.

Meyer lemons, Clementine tangerines and several tangelo varieties bore well.

Citrus Rootstocks: The best citranges for seed production were 45019B and Cunningham. Oranges are showing considerable differences in ripening on various stocks. In general, trifoliata induces early ripening as compared with various citranges. Joppa orange on citrangequat was considerably later in ripening than on other stocks. It is apparent that the same root-stock is not best for all cion varieties.

Date Investigations: Date varieties ripened satisfactorily this season and good crops were secured from nearly all varieties. Amir Haj, Kustawy and Braim looked most promising for quality. Several offshoots of Braim were transplanted in the summer.

Grape Varieties: Good yields were obtained from most grape varieties with about the same results as in 1937. Mocking birds did considerable damage to fruit near the outside fence. About 130 varieties of grapes are now in the station collection.

Grape Rootstocks: Nursery tests with bench grafting have been done for six years. Considering resistance to *Phymatotrichum* root-rot, nematodes and phylloxera, the Dog Ridge variety appears to be the most promising. Among the wild stocks collected, La Pryor has given good results. It is apparent that each cion variety will have to be tested separately to determine the most suitable stock.

Srawberry Varieties and Breeding: Good yields were obtained from nearly all varieties in 1938. The highest yields were from T21, T22, T19, T50, T45, T56, T34, and T68, all of which selections give significantly higher yields than any of the named varieties in the test. Klondike gave the best yield of the named varieties and the following varieties and selections were approximately equal to Klondike in yields: T15, T28, T29, Nor-J, U. S. 652, and T53.

Encouraging results with T21, T22, T68, and T15 led to their release to private growers in the fall. T68 was named "Ranger", T21 "Alamo", and T15 "Riogrande". "Alamo" is particularly noted for strong vigorous plants and high fruit yields. The fruit color is lighter than "Ranger" or "Riogrande" but it is a good shipper.

"Ranger" is a good shipper, dark red and evenly colored, good plant producer and covers fruit and flowers well, thus protecting them from both frost and sun. "Riogrande" is chiefly interesting for firmness and flavor.

Further crosses were made in 1938 with T6, T10, T15, T21, T26, T30, and T65 all pollinated by T68 (Ranger). In the fall, 3,600 seedlings were set in the field for further observation after surviving an unusually hot summer.

E. Mortensen.

Vegetables

Variety Descriptions (In cooperation with the Bureau of Plant Industry, U. S. Department Agriculture): The object of this work has been to obtain definite descriptions of ideal types of the more widely used vegetable varieties. In the fall of 1938 the second crop of peppers and eggplants were grown, the first having been grown in 1937. In the pepper trial there were 92 strains representing 17 sweet varieties and 10 hot varieties. In the eggplants test there were 25 strains representing 9 varieties. The work of selecting strains for study in future seasons was continued, with considerable attention given to the method of making observations in order to facilitate future procedure. Again the crops experienced a hot, dry season, and again it was evident that eggplants are more adapted to such conditions than are peppers. Many varieties of peppers, especially California Wonder, Early Giant, and Ruby King produced, as in 1937, small misshapen and off-type fruit in late September before conditions had become entirely favorable to normal fruit setting. Of the two types, hot peppers seem better adapted than sweet peppers, but given normal conditions most varieties can be depended upon to produce in the fall.

Adaptability Studies: As information along this line had been assembled on a rather extensive scale in the seven years preceding 1938, work in this direction was somewhat reduced allowing time for more attention to other studies. During the year, the following numbers of varieties and strains of vegetables were included in the trials: cucumbers 50, lettuce 59, and tomatoes 19. The tomatoes were grown in more than one season, thus increasing the number of tests made.

Among the newer varieties of cucumbers which showed promise were Ace, A and C, Special Dark Green, Colorado, and Mission. The last named was especially attractive, but might be too long for some growers. No new varieties of importance were discovered in the lettuce trial. Among the tomatoes, Harkness showed up as a prolific bearer in the spring; the fruit, however, tends to be slightly small.

Sources of phosphoric acid for onions: After three seasons of testing the values of phosphoric acid-carrying materials for fertilizing onions results indicate that the 20 and 45 per cent superphosphates are better than the 32 per cent superphosphate, which has consistently resulted in

the lowest yield, in two out of three seasons doing no better than no fertilizer. Bone meal seems even less satisfactory. A high analysis fertilizer such as 11-48-0 applied at a rate to give the same amount of phosphoric acid per acre as with the materials mentioned above caused the onions to produce more heavily every year than any other treatment in this series. This finding is in line with those already reported in Texas Station Bulletin 524.

Supplementary Onion Fertilizer Tests on Other Soils: The tests which were initiated a year ago on a Laredo silt loam at Laredo, a Laredo very fine sandy loam at Eagle Pass, and a Monteola clay at Big Wells were repeated this year. On the basis of two years' results it would seem that onions on all three soil types will yield more when fertilizer is applied. In no location did the application of potash prove profitable. Indications from these tests are that a fertilizer with a 1-2-1 or a 1-2-0 ratio will cause onions to produce just as heavily as one with 1-3-1 or a 1-3-0 ratio. Only on the Laredo very fine sandy loam at Eagle Pass has a nitrate side dressing been profitable in both years.

Pruning Tomatoes: For the third successive year pruning spring-planted tomatoes to one or two stems resulted in higher early yields than where the plants were left unpruned. Pruned plants usually had ripe fruit earlier, too. After the first five or six pickings, the unpruned plants bear more heavily than the pruned ones, but usually by that time the commercial value of the fruits has dropped considerably. The greater yield from the pruned plants is chiefly a result of the closer planting, pruned plants being spaced 1½ feet apart in 3-foot rows, while the unpruned plants were set 2 feet apart in 4-foot rows. Where plants are plentiful, however, these tests would indicate that it pays to prune and to set them closer together in the field.

Handling Tomatoes in the Seedbed: On the basis of an experiment initiated this year it would seem that growers would do well to give their tomato plants sufficient room in the seedbed. Tomato plants transplanted at a very early stage to a cold frame where they were spaced 3 inches each way yielded in the first four pickings 1,407 pounds of marketable fruit per acre, as compared with 992 pounds from plants which were left in the hotbed, but thinned to 12 plants per foot, and 610 pounds from plants never thinned but left 50 to the foot until they were removed to the field. After eleven pickings the yield from the thinned plants approximately equaled that from those which had been transplanted to a cold frame, but both at that time exceeded that of the unthinned plants by 1,500 pounds per acre.

Canning Crops: In the winter of 1937-38 and throughout 1938, trials with canning crops were made with cooperation of the Agricultural Department of the Missouri Pacific railroad. In the winter plantings, Detroit Dark Red beets and Chantenay carrots gave very satisfactory yields at

various rates of seeding and stages of harvest to get the sizes desired by commercial canners.

Viroflay was the most satisfactory variety of spinach for the canner. In a rate of seeding list with variety varying from 8 to 11 pounds of seed per acre and planted in rows, total yields did not differ very much and were all good.

The results with English peas were promising, but not as satisfactory as those with the crops above. From three times-of-plantings in the fall and three in the spring it was apparent that the number of days from date of planting to date of harvest can vary greatly for any given variety. Height of vine likewise varies. The variety, Pride, gave the most promising yield in the fall; producing at the rate of 3,987 pounds per acre of unshelled pods, or 1,605 pounds more than the next high yielder, Mardelah. On the whole, early fall planting (Sept. 15 to Oct. 1) was more productive of satisfactory results than winter planting (January and early February).

Spring plantings of beans were adversely affected by an unusually high northwest wind on April 7 and 8 and by unusually early high temperatures and low humidity in late May. In the fall all bean trials were brought to an early close by the killing freeze on November 8. Since the average date of the first killing frost is December 6, the yields from all the beans indicate much promise as a fall canning crop. Comparing the spring and fall seasons the data indicate that fall is probably the more favorable of the two seasons for beans.

In the spring, Blue Lake pole beans yielded nearly 3 tons per acre by early June on fine sandy loam. Planted August 15 on the same type of soil they produced over 3½ tons per acre by the time of the freeze and in one less picking than in the spring. On a heavy clay loam a similar planting in the fall yielded nearly a ton less, but these had been slower maturing and had been picked fewer times. As a producer, and as a canning snap bean, Blue Lake gave much promise.

The Idaho Refugee bean variety produced from around 2 tons per acre of snap beans in the spring on sandy loam soil to over 3 tons in the fall on the same soil type. On the heavier clay loam it produced over 3 1/3 tons per acre in the fall.

The Henderson bush lima yielded at the rate of around 1,700 pounds of shelled beans per acre on sandy loam soil in the spring. The beans had been allowed to reach a stage containing 13 per cent white beans. In the fall when the percentage of white beans was only 5 per cent the yield of shelled beans was 1,220 pounds per acre, and when the percentage of whites had reached 5.2 per cent the yield had jumped to 1,400 pounds per acre. Striking were the differences with which canners would have to contend in harvesting conditions in the spring and the fall. In the spring temperatures were relatively high at harvest time and the percentage of white beans increased 3 per cent in 24 hours; in the fall, tem-

peratures were comparatively low at harvest time so that in three days the percentage of white beans only increased 0.2 per cent.

Breeding Vegetable Crops: Selection has been continued in Summerset, a heat resistant tomato which bears fruit in the Winter Garden Region during the months of July, August, and September when the temperature is high and the relative humidity usually low. Summerset has been produced from a cross between Large Cherry and Bonny Best. A number of similar lines of this variety now seem to be have become uniform in size, shape, and appearance of fruit. The work of breeding and selecting for greater size in summer tomatoes is being continued. In juice canning tests conducted by various commercial canners and others in the late fall of 1937 Summerset rated among the best for quality and color of juice.

Breeding work with onions is being continued and expanded. In the spring of 1938 one line of Yellow Bermuda onions consisting of 420 bulbs was harvested, and among these bulbs there was not a single off-color, double, or seeder. They had, however, decreased in size through the inbreeding process, and one onion became slightly pink a month after harvest. It appears that inbreeding combined with selection away from such defects as bolting, doubling and off colors will result in better lines of Yellow Bermuda onions. The work towards the production of a commercial onion variety resistant to thrips is progressing, but very slowly.

Leslie R. Hawthorn.

Plant Diseases

White rust of spinach. This was the most destructive of all the diseases that appeared on spinach during the 1937-1938 season. Every field examined had the disease. It is estimated that the average yield in the Winter Garden area was reduced by more than 25 per cent on account of this disease alone. This disease has been known among the growers for several years but apparently its ravages have never been so apparent before. There seems to be no published record concerning the occurrence of this disease on spinach anywhere else in the world. The disease is readily recognizable by the small white pustules (sori) comprising masses of conidia found scattered mainly on the underside of the leaf, but in severe cases on the upper side also. The affected leaves in time turn light brown and die. Yellowing and mosaic-like coloration of affected leaves without white pustules may occur under some conditions.

The disease is caused by the fungus *Albugo occidentalis* Wilson. The identity of the parasite was definitely established by the discovery of its sexual spores (oospores) which are found lodged within the diseased plant tissue. These spores seem indistinguishable from those found within the tissue of strawberry blite (*Chenopodium capitatum*) which have been known to be attacked by the white rust for some time. When and how the white rust infected spinach for the first time is not known. The parasite may have attacked spinach for a long time without being recog-

nized, but it seems also likely that the fungus may have passed on to spinach from the strawberry blite which is found in North Texas.

The resistance to this disease of nearly 120 spinach varieties and strains collected from many sources was tested during the 1937-1938 season on the grounds of the substation at Winter Haven, Texas, and at Eagle Pass, Texas, in cooperation with a grower. The disease showed in severe form at both places. Significant differences in resistance were found among the different spinach varieties, the damage caused by the disease varying from 10 to 90 per cent. The nature of this resistance is not known, but it appears that the larger and more vigorous growing varieties suffered less from the disease than the smaller varieties. The varieties which showed less than 20 per cent damage were Broad Flanders, King of Denmark, Viroflay, Victoria, Zwann's Dark Green Bloomsdale, Zwann's Darkie, Prickly Winter, Harlem Market, and Dark Green Giant Prickly. As a whole the flat leaf varieties, which also reach larger size, suffered less damage than the savoyed types on the testing grounds and in the commercial fields as well. The same varieties and strains are being again tested during the 1938-1939 spinach growing season.

Cooperation was given in preliminary dusting experiments made by an airplane crop dusting corporation on farms at La Pryor and Eagle Pass, Texas. Good coverage was obtained where hand dusters gave inadequate coverage.

Pink Root of Onions. Pink root of onions is an important disease in the Winter Garden region of Texas where considerable acreage is devoted to the Bermuda type of onions. During the 1937-1938 season it was found in the majority of fields examined and in a few cases it was one of the important causes for the total failure of the crop.

More than twenty isolations of the causal organism were made from diseased onions collected from various parts of the state and in a few cases from other states. The isolations indicate that this disease is caused by a species of *Phoma*, probably *Phoma terrestris* Hansen.

Many thousands of onion bulbs were examined for resistance from three onion fields which were severely infested with pink root, and only relatively few were found nearly free, but not entirely free, of pink root. These have again been reselected for desirable commercial qualities and the best bulbs planted for further resistance tests.

Onion "blight." A disease on onion plants in the seedbed, apparently little known generally, but of economic importance in the Winter Garden region, appeared in severe form during the 1937-1938 growing season. Among the growers it is known as onion blight, or onion wilt. In some fields it reduced the yield by at least 25 per cent, and in addition lowered the quality of the surviving plants. The symptoms are the drying of the leaf tips followed by necrosis, and in the appearance of numerous small, roundish, white to grayish spots all over the leaves. The base of the

seedling becomes dry and flaccid. The disease seems to be favored by wet weather followed by dry, hot weather. Attempts to isolate a causal organism have failed. It is thought that this disease is of nonparasitic nature. It has been artificially reproduced once under controlled conditions. Further studies on its cause and possible control are in progress.

Curly Top of Spinach. Plantings were made with about 120 varieties and strains of spinach (see White Rust of Spinach) in tests for resistance to curly top. Fortunately for the spinach growers the disease showed in relatively unimportant form and it was not possible to make selections for resistance.

Tomato fruit "pox." A disease on tomato fruits, provisionally named tomato fruit "pox," was first noticed in 1937 in scattered fields to a slight extent, but during the fall of 1938 it occurred in severe form and damaged the fruit in some fields to the extent that about 10 per cent of the harvested fruits were considered unmarketable for "greenwrap." The symptoms appear at first as few to numerous small, dark green or olive green spots, about 1 to 2 mm. in diameter, scattered all over the green fruit, but found particularly near the stem end. At this stage of the development of the disease the green fruits have a mosaic-like appearance. As the fruit ripens some of these dark green spots develop into pits with corky tissue bordering them. On fully ripe fruits the pits turn into small cracks while the arrested dark green spot which did not turn into pits assume a golden rusty color. Green fruits of all sizes may be affected. Attempts to isolate a pathogenic micro-organism have been so far unsuccessful.

S. S. Ivanoff.

Ornamentals

Trees and Shrubs: No new developments occurred to report this season. *Eucalyptus crucis* attracted much attention because of its unusual foliage.

E. Mortensen.

Field Crops

Corn Varieties: Golden June gave the highest yield with Mexican June a close second. All varieties gave reasonably good yields under irrigation. Golden June appears to be a promising new variety for Southwest Texas.

Cotton Varieties: Poor stands resulted from the high winds on April 7 and 8 and consequently low yields were secured. Rogers Acala appears to be one of the better varieties for planting under irrigation.

Flax Varieties: Yields ranging from 16.7 bu. per acre for Redwing to 29.7 for Giza were obtained from a variety planting made November 12. Punjab averaged 26.6 and Rio 24.8 bu. per acre.

McFadden and Mortensen.

Sugar Cane: A good crop of cane practically free of borers was secured from CP28/19 and CO29/320.

E. Mortensen.

Insect Investigations

Eggplant Yellows: The small leaves at the tips of the branches develop greenish-yellow spots. These spots increase in size and turn orange-yellow, usually following the veins. The disease works down the branches until all of the leaves are chlorotic. Within twenty-five days after the first symptoms appear the plant loses all green coloring and slowly dies. Little is known about this disease and attempts were made to discover the nature of the insect vector if any is involved.

Sulphur in the soil in both the seed bed and field at the rate of 500 pounds per acre reduced the yellows to 7.2 per cent. The untreated plat developed 44 per cent yellow plants. One plat which was dusted in the seed bed and six times in the field with Fuller's earth and Cubé containing 0.75 per cent rotenone but no sulphur developed 5.8 per cent yellowed plants. Approximately fifty species of insects were collected on eggplants during 1938. Although an effort was made to determine if there is a vector, all attempts failed. The nature of the disease and method of transmission are still mysteries, but the application of sulphur produces effective control.

S. E. Jones.

Tomato Fruitworm, (*Heliothis obsoleta* Feb.): Tests were conducted during 1938 to determine if it would be advisable to dilute calcium arsenate, the number of applications necessary, and the time to begin dusting. The 1938 results were statistically analyzed and it was found that either four or five applications at seven-day intervals or three applications at ten-day intervals were equally effective. There were less than half as many wormy fruits on the dusted plats as on those not dusted. Three applications at seven-day intervals, beginning when the first fruits were set, were not effective in controlling the fruitworms.

There was no significant difference between plats dusted four times with calcium arsenate undiluted, where it was diluted with sulphur (75-25) or (50-50), or diluted with hydrated lime (50-50). In plats dusted with calcium arsenate-sulphur (25-75) an effective control was not obtained.

Control obtained in experiments on time of dusting was better where three applications were made at weekly intervals beginning two weeks after the first fruit set than on plats receiving the same number of applications but beginning a week earlier. The results this season indicate that the dust should be applied as late as possible and still avoid having a poisonous residue on the harvested fruits.

S. E. Jones.

Aphis on Spinach: Following a dry summer, aphis became destructive to spinach in November. An entomogenous fungus was effective in killing the aphis in large spinach in fields where the humidity was high following frequent irrigations. This was the first time aphis have been a factor in spinach production in the Wnter Garden since 1931.

S. E. Jones.

Beet Leafhopper on Spinach: The beet leafhopper (*Eutettix tenellus* Baker) infestation remained low following unfavorable weather in December, 1937. The population in West Texas was approximately the same during October 1937 and 1938. Only a small number were found in a survey which covered about 900 miles, and all of these were in the vicinity of Alpine. Since the unprecedented outbreak in January, 1936, neither this insect nor the curly top disease which it transmits has been destructive to spinach in the Winter Garden.

S. E. Jones and M. J. Janes.

Onion Thrips (Thrips tabaci Lind.): The 1938 onion crop was severely damaged by onion thrips. It appeared that the infestation built up in the field as the catch was very low on screen traps. The population on ten varieties of onions varied from 8 to 67 thrips per plant on February 14. In a study of the location of eggs on a plant, it was found that 90 per cent of them were deposited in the lower five inches of the leaves and the rest in the next five inches. The infestation was low on onions in the seed bed during the fall of 1938.

Defoliation of grain sorghum: *Pelamia repanda* Fab. defoliated sorghums, corn, and other plants belonging to the grass family during the latter part of August and in September in Dimit, Zavala, and La Salle counties. Only one generation was observed and the damage ceased by October 1. This is the first time that this pest has appeared since 1934 and the second time since 1916. Poison bran mash was not effective in controlling this insect.

M. J. Janes and S. E. Jones.

COOPERATION

Memoranda of agreement providing for cooperative research have been entered into or continued during the year with the following bureaus of the United States Department of Agriculture:

Bureau of Agricultural Economics:

1. A study of agricultural adjustment in Texas;
2. Cotton fiber and spinning research (also with the Bureau of Plant Industry and the Texas Engineering Experiment Station);
3. A study to determine the economic and social effects on farms resulting from the operation of a definitely planned program of soil conservation;
4. An estimate of the farm population and farm population movements;
5. The accuracy of small samples for wool shrinkage and grading determinations;
6. A study of Texas farm leasing arrangements in relation to the conservation of agricultural resources.

Bureau of Animal Industry:

1. Investigations of the loco problem in Western Texas;
2. Beef cattle husbandry investigations relating to the fattening of steers at different levels of feeding (also with Bureau of Plant Industry);
3. Beef cattle feeding investigations to determine the quantity of carotene required for growing and fattening steers;
4. Beef cattle feeding investigations relating to mineral-deficiency studies in range beef-cattle production;
5. A study of the inheritance of skin folds in Rambouillet sheep;
6. Improvement of sheep for western ranges through the application of breeding methods;
7. The mechanism of infection, resistance, and immunity in the contagious, infectious, and parasitic diseases of domestic animals and poultry.

Bureau of Chemistry and Soils:

1. Research on citrus products and on methods of preservation of fruits and vegetables.

Bureau of Biological Survey:

1. Regional and state wildlife research (also with the Texas Extension Service and the State Game, Fish, and Oyster Commission).

Bureau of Plant Industry:

1. The production, improvement, and diseases of cereal crops, particularly corn, wheat, oats, sorghum, and rice;
2. The production, improvement, and diseases of cotton;
3. Field testing of Satsuma orange varieties and hybrids and stock plants for them;
4. Study and description of American varieties of vegetable crop plants for the purpose of establishing variety type standards;
5. Investigations in the development of forage and soil improving crops adapted to Northern Texas and contiguous areas (at Substation No. 12, Chillicothe);
6. Experiments in the testing of dates at Substation 15, Weslaco, and in Southwest Texas.
7. Investigations on insecticide and tannin plants and their possibilities as crops in the United States;
8. Vegetable breeding investigations in the Southeastern States and at the U. S. Regional Vegetable Breeding Laboratory;
9. Investigations on introduction, breeding, and testing varieties and seedlings of sweet potatoes;

10. Investigations on the occurrence of boron injury to citrus and other crop plants in the Lower Rio Grande Valley;
11. Studies on establishment of the perigord truffle (*Tuber melanosporum*) in America.
12. Soil surveys in Texas.

Bureau of Entomology and Plant Quarantine:

1. Investigations of insects and parasites affecting livestock;
2. Cotton insect investigations, including biology and control of pink bollworm and cotton bollworm;
3. Investigation on the resistance of honey bees to American foulbrood.

Soil Conservation Service:

1. Soil and water conservation research in the State of Texas, at Temple, Tyler, Spur, Amarillo, and Brushy Creek Watershed.

Bureau of Home Economics:

1. Study of body measurements for sizing children's garments and patterns.

LETTER OF TRANSMITTAL

September 15, 1938.

Director A. B. Conner,
Texas Agricultural Experiment Station.

Dear Director Conner:

There is submitted herewith the annual financial report of the Texas Agricultural Experiment Station for the fiscal year ended August 31, 1938.

In accordance with Subsection 1, Chapter 444, General and Special Laws Forty-fifth Legislature, Regular Session, all exhibits and schedules contained in this report have been prepared as nearly as practicable in conformity with the suggestions made by the National Committee on Standard Reports for Institutions of Higher Education.

Respectfully submitted,

M. P. HOLLEMAN, Chief Clerk.

Approved:

W. H. HOLZMANN,
Comptroller of Accounts.

TEXAS AGRICULTURAL EXPERIMENT STATION

EXHIBIT A

Texas Agricultural Experiment Station Balance Sheet
As at August 31, 1938

ASSETS

I. CURRENT FUNDS

A. RESEARCH AND GENERAL

Cash.....		\$	100,720.08	
Balance in State Appropriations (Schedule B-1a).....			29,055.07	
Feed Control Tags				
Inventory.....	\$	1,874.51		
C. O. D. Shipments.....		226.17	2,100.68	
Supplies and Crop Inventories				
Supplies.....		123,777.19		
Crops.....		6,294.50	130,071.69	
Total Research and General.....				\$ 261,947.52

B. AUXILIARY ENTERPRISES AND
ACTIVITIES.....

None

CURRENT RESTRICTED FUNDS

Cash.....	\$	1,529.94		
Total Current Restricted Funds.....				\$ 1,529.94

TOTAL CURRENT FUNDS ASSETS

\$ 263,477.46

II. LOAN FUNDS.....

None

III. ENDOWMENT FUNDS.....

None

IV. PLANT FUNDS

A. UNEXPENDED.....

None

B. INVESTED IN PLANT

Physical Plant (Exhibit E)..... \$1,181,451.08

Total Invested in Plant..... \$1,181,451.08

TOTAL PLANT FUNDS ASSETS.....

\$1,181,451.08

V. AGENCY FUNDS.....

None

GRAND TOTAL ASSETS.....

\$1,444,928.54

EXHIBIT A

Texas Agricultural Experiment Station Balance Sheet
As at August 31, 1938

LIABILITIES

I. CURRENT FUNDS			
A. RESEARCH AND GENERAL			
Accounts Payable			
Main College—Working Fund.....	\$	10,000.00	
Main College—Feed Control Tag			
Inventory and C. O. D's.....		2,100.68	\$ 12,100.68
Reserve for Supplies and Crops Inventories.....			
			\$ 130,071.69
Revolving Funds Balances (Sch. B-4).			
			8,166.21
Current Balances (Exh. B)			
Appropriated for Special Purposes			
Federal Hatch Fund Balance....	\$	1,540.31	
Federal Adams Fund Balance....		1,390.85	
Federal Purnell Fund Balance....		5,612.99	
Federal Bankhead-Jones Fund			
Balance.....		15,329.08	
State Apprns. Bals.—Main Station		2,970.10	
State Apprns. Bals.—Substations.		5,854.82	
Sales Funds Bals.—Main Station.		26,839.63	
Sales Funds Bals.—Substations..		31,841.01	
Total Appro. for Special Purposes....			91,378.79
Reserve for Contracts and Orders....			20,230.15
Total Research and General.....			\$ 261,947.52
B. AUXILIARY ENTERPRISES AND ACTIVITIES			
			None
C. CURRENT RESTRICTED FUNDS			
Fund Balances			
(Per Exhibit B and Schedule B-3)...	\$	1,529.94	
Total Current Restricted Funds.....			1,529.94
TOTAL CURRENT FUNDS LIABILITIES			\$ 263,477.46
II. LOAN FUNDS			
			None
III. ENDOWMENT FUNDS			
			None
IV. PLANT FUNDS			
A. UNEXPENDED			
			None
B. INVESTED IN PLANT (Exhibit E)			
Net Investment in Plant.....	\$1,181,451.08		
Total Invested in Plant.....			\$1,181,451.08
TOTAL PLANT FUNDS LIABILITIES			\$1,181,451.08
V. AGENCY FUNDS			
			None
GRAND TOTAL LIABILITIES			\$1,444,928.54

EXHIBIT B

Summary Statement of Current Funds

For the Year Ended August 31, 1938

BALANCES, September 1, 1937

Current Funds—Research and General			
Reserve for Outstanding Orders.....		\$	1,799.55
Appropriated for Special Purposes			
Federal—Hatch Fund.....	\$	1,403.59	
Federal—Adams Fund.....		1,250.03	
Federal—Purnell Fund.....		5,034.45	
Federal—Bankhead-Jones Fund.....		16,397.89	
State Apprns.—Main Station.....		648.61	
State Apprns.—Substations.....		99.58	
Sales Funds—Main Station.....		26,079.81	
Sales Funds—Substations.....		32,522.75	
		83,436.71	\$ 85,236.26
Current Restricted Funds			
Cuprocide Fund.....	\$	583.70	
Texas Gulf Sulphur Fund.....		1,233.78	
Freeport Sulphur Fund.....		524.71	
Special Fertilizer Fund.....		49.21	2,391.40

TOTAL BALANCES, September 1, 1937..... \$ 87,627.66

ADD:

Current Research and General Income			
(Schedule B-1).....		\$744,517.34	

DEDUCT:

Current Research and General Expenditures			
(Schedule B-2).....	\$718,257.93		
Unused 1936-37 Leg. Appro. reverted (Sch. B-1a)...	748.19	719,006.12	
Net Deductions.....			25,511.22

BALANCES, August 31, 1938..... \$113,138.88

Consisting of:

Current Funds—Research and General			
(To Exhibit A, Section I-A)			
Reserve for Outstanding Orders.....		\$	20,230.15
Appropriated for Special Purposes			
Federal—Hatch Fund.....	\$	1,540.31	
Federal—Adams Fund.....		1,390.85	
Federal—Purnell Fund.....		5,612.99	
Federal—Bankhead-Jones Fund.....		15,329.08	
State Apprns.—Main Station.....		2,970.10	
State Apprns.—Substations.....		5,854.82	
Sales Funds—Main Station.....		26,839.63	
Sales Funds—Substations.....		31,841.01	
		91,378.79	\$111,608.94

Current Restricted Funds

Texas Gulf Sulphur Fund.....	\$	922.18	
Freeport Sulphur Fund.....		607.76	1,529.94

Total, as shown above..... \$113,138.88

SCHEDULE B-1

Statement of Current Income

For the Year Ended August 31, 1938

	Total	Current General Funds	Current Restricted Funds
I. RESEARCH AND GENERAL			
1. Student Fees (None)			
2. Public Appropriations			
a. Federal			
Hatch Act (1881).....	\$ 15,000.00	\$ 15,000.00	
Adams Act (1906).....	15,000.00	15,000.00	
Purnell Act (1925).....	60,000.00	60,000.00	
Bankhead-Jones Act (1935).....	116,691.21	116,691.21	
Total Federal.....	\$ 206,691.21	\$ 206,691.21	
b. State Legislative Appropriations (Schedule B-1a and B-1b).....	411,633.00	411,633.00	
Total Public Appropriations.....	\$ 618,324.21	\$ 618,324.21	
3. Endowment Income (None)			
4. Gifts and Grants (Schedule B-3).....	4,407.98		\$ 4,407.98
5. Sales and Services (Schedule B-1c).....	121,423.50	121,423.50	
6. Other Sources			
Interest on Bank Balances.....	361.65	361.65	
Total Research and General (to Exhibit B)....	\$ 744,517.34	\$ 740,109.36	\$ 4,407.98

SCHEDULE B-1a

Summary of State Legislative Appropriations

For Fiscal Year Ended August 31, 1938

	Total	Main Station	Substations
Balances, September 1, 1937, from Appropriations for Previous Year.....	\$ 2,547.74	\$ 1,473.03	\$ 1,074.71
Add Appropriations for Current Year (Sch. B-1b)...	411,633.00	172,593.00	239,040.00
Total Balances from Previous Year, plus Approp- riations for Current Year.....	\$ 414,180.74	\$ 174,066.03	\$ 240,114.71
Less Expenditures (Sch. B-2).....	384,377.48	169,671.40	214,706.08
Unexpended Balances.....	\$ 29,803.26	\$ 4,394.63	\$ 25,408.63
Less Reversions to State Treasury from Previous Year Balances (to Exhibit B).....	748.19	648.61	99.58
Balance, August 31, 1938 (to Exhibit A).....	\$ 29,055.07	\$ 3,746.02	\$ 25,309.05

TEXAS AGRICULTURAL EXPERIMENT STATION

SCHEDULE B-1b

Statement of Current Income from State Legislative Appropriations
(General Revenue)

For the Year Ended August 31, 1938

(Pages 955 to 965, Gen. and Special Laws, 45th Leg. Regular Session)

MAIN STATION:

State Appro.

Number

X-912	—Salaries.....	\$ 49,597.00	
	Less amount accounted for under Substations.....	6,435.00	\$ 43,162.00
X-913	—Administrative.....	\$ 14,150.00	
	Less amount transferred to State Auditor's Department.....	450.00	13,700.00
X-914-15	—Veterinary Science.....		2,600.00
X-916-17	—Horticulture.....		3,450.00
X-918-19	—Range Animal Husbandry.....		6,380.00
X-920-23	—Entomology (Including Foul Brood).....		11,126.00
X-924-25	—Apiculture.....		6,355.00
X-926-27	—Agronomy.....		3,280.00
X-928-29	—Main Station Farm.....		4,610.00
X-930-35	—Plant Pathology.....		7,480.00
X-936-37	—Soil Survey.....		8,330.00
X-938-39	—Farm and Ranch Economics.....		5,170.00
X-940	—Publications.....		5,000.00
X-941	—Botany.....		250.00
X-942-48	—Cotton Root Rot Investigations.....		20,725.00
X-949-50	—Cotton Insect Investigations.....		13,435.00
X-951-52	—Leco Weed Research.....		6,040.00
X-953	—Sweet Potato Investigations.....		3,500.00
X-1045	—Grape Investigations.....		5,000.00
X-1045	—Grape Investigations (Deficiency).....		1,000.00
X-1052	—A. & M. Board's Lease Fund.....		2,000.00
Total Main Station.....			\$ 172,593.00

SUBSTATIONS:

X-912	—Salaries (See Main Station).....	\$ 6,435.00
X-954-64	—No. 1—Beeville.....	25,460.00
X-965-73	—No. 2—Tyler.....	15,410.00
X-974-80	—No. 3—Angleton and Plant Lice Laboratory.....	35,960.00
X-981-83	—No. 4—Beaumont.....	9,310.00
X-984-85	—No. 5—Temple.....	8,710.00
X-986-88	—No. 6—Denton.....	7,910.00
X-989-93	—No. 7—Spur.....	8,700.00
X-994-98	—No. 8—Lubbock.....	8,950.00
X-999-1000	—No. 9—Balmorhea.....	4,310.00
X-1001-4	—No. 10—College Station (Feeding and Breeding).....	12,120.00
X-1005-6	—Division of Dairy Husbandry.....	2,400.00
X-1007-8	—Division of Swine Husbandry.....	4,200.00
X-1009-10	—Division of Poultry Husbandry.....	3,700.00
X-1011-22	—No. 11—Nacogdoches.....	21,260.00
X-1023-25	—No. 12—Chillicothe.....	16,310.00
X-1026-30	—No. 14—Sonora.....	13,545.00
X-1031-36	—No. 15—Weslaco (Lower Rio Grande).....	13,805.00
X-1037-39	—No. 16—Iowa Park (Wichita Valley).....	8,350.00
X-1040-44	—No. 19—Winter Haven.....	12,165.00

Total Substations.....	\$239,040.00
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Total State Legislative Appropriations.....	\$411,633.00
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SCHEDULE B-1c

Statement of Current Income from Sales and Services

For the Year Ended August 31, 1938

MAIN STATION:

Administrative.....	\$ 266.87
Veterinary Science.....	666.40
Horticulture.....	33.36
Range Animal Husbandry.....	130.21
Entomology.....	401.41
Apiculture.....	48.00
Agronomy.....	567.89
Main Station Farm.....	2,057.11
Plant Pathology.....	47.30
Farm and Ranch Economics.....	2.89
Leco Weed Research.....	72.37
Chemical Analysis.....	18,546.69
Photographic Laboratory.....	3,007.06
Big Spring Cattle Feeding.....	1,242.68
Rural Home Research.....	190.65

Total Main Station..... \$ 27,280.89

SUBSTATIONS:

No. 1—Beeville.....	\$ 1,669.84
No. 2—Tyler.....	1,464.83
East Texas Soil Erosion.....	374.53
No. 3—Angletcn.....	1,860.53
Plant Lice Laboratory.....	63.50
No. 4—Beaumont.....	768.61
No. 5—Temple.....	565.95
Temple Soil Erosion.....	4,240.33
No. 6—Denton.....	3,632.11
No. 7—Spur.....	13,655.82
No. 8—Lubbock.....	3,807.13
No. 9—Balmcrhea.....	3,679.13
No. 10—College Station (Feeding and Breeding).....	1,275.34
Division of Dairy Husbandry.....	15,947.40
Division of Swine Husbandry.....	8,555.96
Division of Poultry Husbandry.....	4,572.39
No. 11—Nacogdoches.....	918.13
No. 12—Chillicothe.....	2,452.31
No. 14—Sonora.....	12,668.48
No. 15—Weslco (Lower Rio Grande).....	5,305.75
No. 16—Iowa Park (Wichita Valley).....	909.88
No. 19—Winter Haven.....	4,187.94
Amarillo Soil Conservation.....	1,566.72

Total Substations..... \$ 94,142.61

Total Sales and Services..... \$121,423.50

TEXAS AGRICULTURAL EXPERIMENT STATION

SCHEDULE B-2
Statement of Current Expenditures
For the Year Ended August 31, 1938

RESEARCH AND GENERAL	FUND DISTRIBUTION				OBJECT CLASSIFICATION			
	CURRENT GENERAL FUNDS			Current Restricted Funds	Grand Total	Salaries and Wages	Other Operating Expense	Equipment
	Federal Funds	State Apprs.	Sales Funds					
Main Station:								
Administrative.....	\$ 16,051.84	\$ 30,099.45	\$ 1,011.15		\$ 47,162.44	\$ 31,297.00	\$ 5,185.00	\$ 10,680.44
Veterinary Science.....	14,785.83	5,815.00	1,329.43		21,930.26	16,433.65	4,323.64	1,172.97
Horticulture.....	6,949.03	16,118.49	23,083.44	\$ 528.80	33,612.24	16,021.16	2,564.82	2,131.90
Range Animal Husbandry.....	26,769.25	11,565.95	814.10		39,149.30	28,367.55	5,477.18	3,370.47
Entomology.....	8,910.26	27,117.52	418.69		36,446.47	31,687.44	5,524.64	649.99
Apiculture.....		6,380.46	105.13		6,485.59	5,512.27	918.77	54.55
Agronomy.....	17,893.17	7,780.00	581.43		26,254.60	21,691.88	3,687.23	819.76
Main Station Farm.....		4,610.00	2,832.27		7,442.27	5,828.01	1,593.08	91.20
Plant Pathology.....	2,124.46	7,691.19	53.22		9,868.87	9,350.58	1,559.85	335.14
Soil Survey.....	500.00	8,189.97	358.38	2,175.83	12,044.70	9,350.58	1,119.26	336.64
Farm and Ranch Economics.....	33,637.16	6,960.79	40,600.84		9,028.90	7,573.00	2,824.04	241.13
Publications.....	200.00	7,080.00	2.89		7,280.00	37,435.67	4,983.15	16.85
Botany.....	1,320.00	1,464.82			2,784.82	2,520.00	256.33	8.49
Cotton Root Rot Research.....	825.00	20,705.30			21,530.30	17,642.25	2,024.17	1,349.52
Loco Weed Research.....		5,945.00			6,082.12	5,515.25	527.12	39.75
Chemistry.....	20,178.68		137.12		36,726.87	31,249.48	3,653.28	1,824.11
Photographic Laboratory.....		1,330.00	16,948.19		3,849.84	2,605.35	952.02	292.47
Rural Home Research.....	18,950.61		2,499.84		19,145.02	10,079.85	2,173.56	891.61
Agricultural Engineering.....	6,686.47	797.46	194.41		7,493.93	6,427.62	474.73	591.58
Total Main Station.....	\$ 175,791.76	\$ 169,671.40	\$ 26,832.72	\$ 4,120.23	\$ 376,466.11	\$ 293,518.01	\$ 50,151.15	\$ 25,558.57
Substations:								
No. 1—Beaville.....		\$ 24,915.00	\$ 765.74		\$ 25,680.74	\$ 7,442.62	\$ 4,006.87	\$ 3,863.50
No. 2—Tyler.....	\$ 645.00	15,431.50	2,323.52		18,400.02	13,888.04	2,381.38	\$ *10,367.75
No. 3—Angleton.....		8,187.25	9,657.29		9,152.54	7,552.34	1,451.28	1,636.77
Plant Lice Laboratory.....		4,400.00	105.12		4,505.12	3,840.00	646.62	35.00
No. 4—Beaumont.....		9,371.89	579.74		9,951.63	6,276.02	1,624.08	1,233.53
No. 5—Temple.....		8,710.00	3,009.51		11,809.51	6,837.37	3,781.22	816.00
No. 6—Denton.....		7,910.00	5,008.25		12,918.25	6,436.05	4,332.34	912.89
No. 7—Spur.....	2,400.00	8,700.00	12,145.23		23,245.23	12,254.97	5,397.09	578.07
No. 8—Lubbock.....		8,950.00	4,920.77		13,870.77	10,562.75	1,504.63	5,665.08
No. 9—Baltimore.....		4,310.00	5,203.21		9,513.21	5,297.12	1,713.39	1,494.78
Total Substations.....								
Total Main Station.....	\$ 175,791.76	\$ 169,671.40	\$ 26,832.72	\$ 4,120.23	\$ 376,466.11	\$ 293,518.01	\$ 50,151.15	\$ 25,558.57
Total Expenditures.....								
Total Main Station.....	\$ 175,791.76	\$ 169,671.40	\$ 26,832.72	\$ 4,120.23	\$ 376,466.11	\$ 293,518.01	\$ 50,151.15	\$ 25,558.57
Total Substations.....								
Total Expenditures.....								

No. 10—College Station (Feeding and Breeding)	12,120.00	1,249.24	13,369.24	13,369.24	4,799.20	2,563.28	5,755.24
Division of Dairy Husbandry	3,300.00	15,977.72	26,472.71	26,472.71	11,150.20	12,357.23	2,272.88
Division of Swine Husbandry	7,194.99	8,213.08	25,771.90	25,771.90	9,582.23	8,695.05	2,287.96
Division of Poultry Husbandry	10,713.82	4,872.45	18,070.65	18,070.65	11,991.11	6,310.25	769.29
No. 11—Nacogdoches	6,608.20	6,590.00	24,138.30	24,138.30	14,944.79	4,039.55	1,089.17
No. 12—Chillicothe	1,230.00	22,050.26	2,361.02	19,271.02	5,121.16	1,082.86	251.00
No. 13—Sonora	600.00	16,310.00	12,257.51	27,127.51	17,650.01	7,904.21	1,573.29
No. 14—Sonora	1,325.00	13,545.00	7,703.33	21,078.52	13,959.63	3,404.06	2,166.94
No. 15—Weslaco (Lower Rio Grande)	13,375.19	7,519.99	888.07	8,408.06	7,000.12	1,131.21	211.73
No. 16—Iowa Park (Wichita Valley)	150.00	4,688.75	17,003.75	149.21	13,117.90	3,613.53	333.56
No. 19—Winter Haven	245.17	638.76	883.93	883.93	383.12	490.81	87.67
Amarillo Soil Conservation							
Total Substations	\$ 31,112.18	\$ 94,824.35	\$ 340,642.61	\$ 1,149.21	\$ 931,791.82	\$ 190,977.75	\$ 80,292.67
Total Research and General (Exh. B)	\$ 206,903.94	\$ 121,707.07	\$ 712,988.49	\$ 5,209.44	\$ 718,257.93	\$ 484,495.76	\$ 130,443.82
							\$ 51,037.90
							\$ 45,042.07

Consisting of:	
Buildings and Other Improvements	\$ 32,092.98
Land	20,187.47
Total	\$ 52,280.45
Add Equipment	51,037.90
Total Investment in Plant (Exhibit E)	\$ 103,318.35

Analysis by Sources of Funds and Expense Classes

	DISTRIBUTION BY DIVISIONS		Total	DISTRIBUTION BY EXPENSE CLASSES			
	Main Station	Substations		Salaries and Wages	Other Operating Expense	Equipment	Buildings and Other Improvements
RESEARCH AND GENERAL EXPENDITURES							
Current General Funds							
Federal Funds							
Hatch Fund	\$ 13,968.28	\$ 895.00	\$ 14,863.28	\$ 13,251.94	\$ 1,478.19	\$ 133.15	
Adams Fund	14,259.18	600.00	14,859.18	12,997.74	464.02	1,386.35	11.07
Purnell Fund	56,611.46	2,810.00	59,421.46	53,014.63	4,846.51	1,441.48	78.49
Bankhead-Jones Fund	90,952.84	26,807.18	117,760.02	88,605.06	14,279.00	7,249.43	7,626.53
Total Federal Funds	\$ 175,791.76	\$ 31,112.18	\$ 206,903.94	\$ 187,869.42	\$ 21,068.02	\$ 10,250.41	\$ 7,716.09
State Appropriations	\$ 169,671.40	\$ 214,706.08	\$ 384,377.48	\$ 263,310.65	\$ 54,471.16	\$ 26,806.52	\$ *39,789.15
Sales Funds	26,882.72	94,824.35	121,707.07	49,789.52	53,305.45	13,836.89	4,775.21
Total Current General Funds	\$ 372,345.88	\$ 340,642.61	\$ 712,988.49	\$ 480,969.59	\$ 128,844.63	\$ 50,893.82	\$ 52,280.45
Current Restricted Funds (Schedule B-3)	4,120.23	1,149.21	5,269.44	3,526.17	1,599.19	144.08	
Total Research and General Expenditures	\$ 376,466.11	\$ 341,791.82	\$ 718,257.93	\$ 484,495.76	\$ 130,443.82	\$ 51,037.90	\$ 52,280.45

*Includes \$7,455.00 at No. 1; \$732.47 at No. 11, and \$12,000.00 at No. 12, for purchase of land.

TEXAS AGRICULTURAL EXPERIMENT STATION

SCHEDULE B-2a

Statement of Federal Hatch Fund

For the State Fiscal Year Ended August 31, 1938

Balance, September 1, 1937.....	\$	1,403.59	
Received from United States Treasurer.....		15,000.00	
Balance, September 1, 1937, plus additions.....	\$		16,403.59
Less Expenditures:			
Personal Services.....	\$	13,251.94	
Supplies and Materials.....		250.33	
Communication Service.....		17.54	
Travel Expenses.....		803.28	
Printing and Illustrating Publications.....		30.00	
Equipment.....		157.68	
Buildings and Land.....		352.51	
Total Expenditures.....			14,863.28
Balance, August 31, 1938.....	\$		<u>1,540.31</u>

Note: Income and Expenditures are included in Schedule B-1 and B-2.

SCHEDULE B-2b

Statement of Federal Adams Fund

For the State Fiscal Year Ended August 31, 1938

Balance, September 1, 1937.....	\$	1,250.03	
Received from United States Treasurer.....		15,000.00	
Balance, September 1, 1937, plus additions.....	\$		16,250.03
Less Expenditures:			
Personal Services.....	\$	12,997.74	
Supplies and Materials.....		387.92	
Travel Expenses.....		76.10	
Equipment.....		1,386.35	
Buildings and Land.....		11.07	
Total Expenditures.....	\$		14,859.18
Balance, August 31, 1938.....	\$		<u>1,390.85</u>

Note: Income and Expenditures are included in Schedule B-1 and B-2.

SCHEDULE B-2c

Statement of Federal Purnell Fund

For the State Fiscal Year Ended August 31, 1938

Balance, September 1, 1937.....	\$	5,034.45	
Received from United States Treasurer.....		60,000.00	
Balance, September 1, 1937; plus additions.....	\$		65,034.45
Less Expenditures:			
Personal Services.....	\$	53,014.68	
Supplies and Materials.....		2,160.48	
Communication Service.....		346.00	
Travel Expenses.....		1,203.23	
Transportation of Things.....		124.22	
Heat, Light, Water and Power.....		61.73	
Contingent Expenses.....		25.23	
Equipment.....		2,001.99	
Buildings and Land.....		483.90	
Total Expenditures.....	\$		59,421.46
Balance, August 31, 1938.....	\$		5,612.99

Note: Income and Expenditures are included in Schedule B-1 and B-2.

SCHEDULE B-2d

Statement of Federal Bankhead-Jones Fund

For the State Fiscal Year Ended August 31, 1938

Balance, September 1, 1937.....	\$	16,397.89	
Received from United States Treasurer.....		116,691.21	
Balance, September 1, 1937; plus additions.....	\$		133,089.10
Less Expenditures:			
Personal Services.....	\$	88,605.06	
Supplies and Materials.....		10,594.94	
Communication Service.....		75.91	
Travel Expenses.....		2,517.43	
Transportation of Things.....		20.88	
Heat, Light, Water and Power.....		205.56	
Contingent Expenses.....		2.35	
Equipment.....		7,528.29	
Buildings and Land.....		8,209.60	
Total Expenditures.....	\$		117,760.02
Balance, August 31, 1938.....	\$		15,329.08

Note: Income and Expenditures are included in Schedule B-1 and B-2.

EXHIBIT E

Summary Statement of Investment in Plant

At August 31, 1938

CARRYING VALUE OF PLANT, SEPTEMBER 1, 1937...		\$1,092,327.88
ADDITIONS DURING 1937-38:		
1. Expended from Plant Funds (None)		
2. Expended from Current General Funds	\$ 103,174.27	
3. Expended from Current Restricted Funds (Sch. B-3)	144.08	
Total Current General and Current Restricted Funds (Schedule B-2)	\$ 103,318.35	
4. Expended from Revolving Funds (Schedule B-4)	14,921.66	
5. Expended from Feed Control Service Funds (Exh. G)	1,925.82	
6. Adjustments to previously reported values	8,176.84	
Total Additions		128,342.67
Carrying Value of Plant, September 1, 1937, plus additions		\$1,220,670.55
DEDUCT:		
1. Sale of Equipment	\$ 20,430.31	
2. Plant assets worn out, discarded, etc.	8,713.36	
3. Transferred to A. & M. College Inventory	10,075.80	
Total Deductions		39,219.47
VALUE OF PLANT, August 31, 1938 (to Exhibit A)		<u>\$1,181,451.08</u>
Value of Plant at August 31, 1938, made up as follows:		
Land		\$ 291,676.10
Buildings	\$ 425,444.74	
Improvements Other Than Buildings	38,029.32	
Total Buildings and Other Improvements		463,474.06
Equipment		426,300.92
Total (to Exhibit A)		<u>\$1,181,451.08</u>

TEXAS AGRICULTURAL EXPERIMENT STATION

SCHEDULE E-1

Summary Statement of Inventory Valuation

At August 31, 1938

MAIN STATION

Administrative.....	\$ 40,513.25
Veterinary Science.....	34,337.14
Horticulture.....	23,271.07
Range Animal Husbandry.....	31,642.32
Entomology.....	17,466.41
Apiculture.....	18,039.75
Agronomy.....	19,970.32
Main Station Farm.....	44,345.94
Plant Pathology and Physiology.....	9,772.47
Soil Survey.....	2,817.52
Farm and Ranch Economics.....	6,351.28
Publications.....	45,688.27
Botany.....	4,161.31
Loco Weed Research Laboratory.....	3,530.96
Chemistry.....	38,474.73
Photographic Laboratory.....	5,210.28
Rural Home Research.....	20,411.50
Agricultural Engineering.....	7,062.62
Feed Control Service.....	6,061.37

Total Main Station..... \$ 379,158.51

SUBSTATIONS

No. 1—Beeville.....	\$ 37,021.79
No. 2—Tyler.....	38,337.40
No. 3—Angleton.....	25,459.52
Plant Lice Laboratory.....	4,449.42
No. 4—Beaumont.....	39,215.05
No. 5—Temple.....	59,826.91
No. 6—Denton.....	34,013.08
No. 7—Spur.....	59,144.08
No. 8—Lubbock.....	37,902.03
No. 9—Balmorhea.....	32,660.39
No. 10—College Station (Feeding and Breeding Station).....	53,391.06
Division of Dairy Husbandry.....	30,228.51
Division of Swine Husbandry.....	24,243.59
Division of Poultry Husbandry.....	18,899.20
No. 11—Nacogdoches.....	45,326.02
No. 12—Chillicothe.....	45,015.73
No. 14—Sonora.....	158,071.15
No. 15—Weslaco (Lower Rio Grande).....	117,365.95
No. 16—Iowa Park (Wichita Valley).....	33,883.73
No. 19—Winter Haven.....	37,909.65

Total Substations..... \$ 932,364.26

Total Inventory Valuation..... \$1,311,522.77

Consisting of:

Supplies and Crops Inventories..... \$ 130,071.69

Invested in Plant..... 1,181,451.08

\$1,311,522.77

EXHIBIT F

Transactions of the Feed Control Service

For the Fiscal Year Ended August 31, 1938

INCOME			
Tag Sales.....	\$	154,283.31	
Total Income.....			\$ 154,283.31
EXPENDITURES			
Salaries and Wages			
Administrative Salaries.....	\$	10,125.00	
Instruction and Research Salaries.....		16,850.00	
Clerical and Stenographic Salaries.....		10,060.00	
Other Salaries.....		1,895.00	
Wages.....		2,940.20	\$ 41,870.20
Consumable Supplies			
Postage, Stationery and Office Supplies.....	\$	1,976.74	
Tags (Purchased).....		19,955.90	
Other Consumable Supplies.....		577.99	22,510.63
Expense			
Telegraph and Telephone.....	\$	385.75	
Travel.....		11,010.62	
Transportation of Things (Service).....		49.22	
Publications.....		8,424.91	
Heat, Light, Power, Water and Gas.....		3,556.42	
Other Current Expenses (Including Chemical Analysis)...		18,677.10	
Refunds.....		497.28	42,601.30
Repairs and Alterations			
Repairs to Buildings.....	\$	2,224.86	
Other Repairs.....		95.50	2,320.36
Total Salaries and Wages plus Operating Expenses...			\$ 109,302.49
Equipment			
Main Office			
Furniture and Office Equipment.....	\$	641.08	
Books.....		33.90	
Other Equipment.....		16.50	
Total Main Office.....	\$		691.48
Other Divisions			
Division of Botany			
Herbarium.....	\$	1,234.34	
Total Other Divisions.....			1,234.34
Total Equipment.....			1,925.82
Total Expenditures.....	\$		111,228.31
Surplus Transferred to A. & M. College.....			43,055.00
Total Expenditures and Surplus.....	\$		154,283.31

